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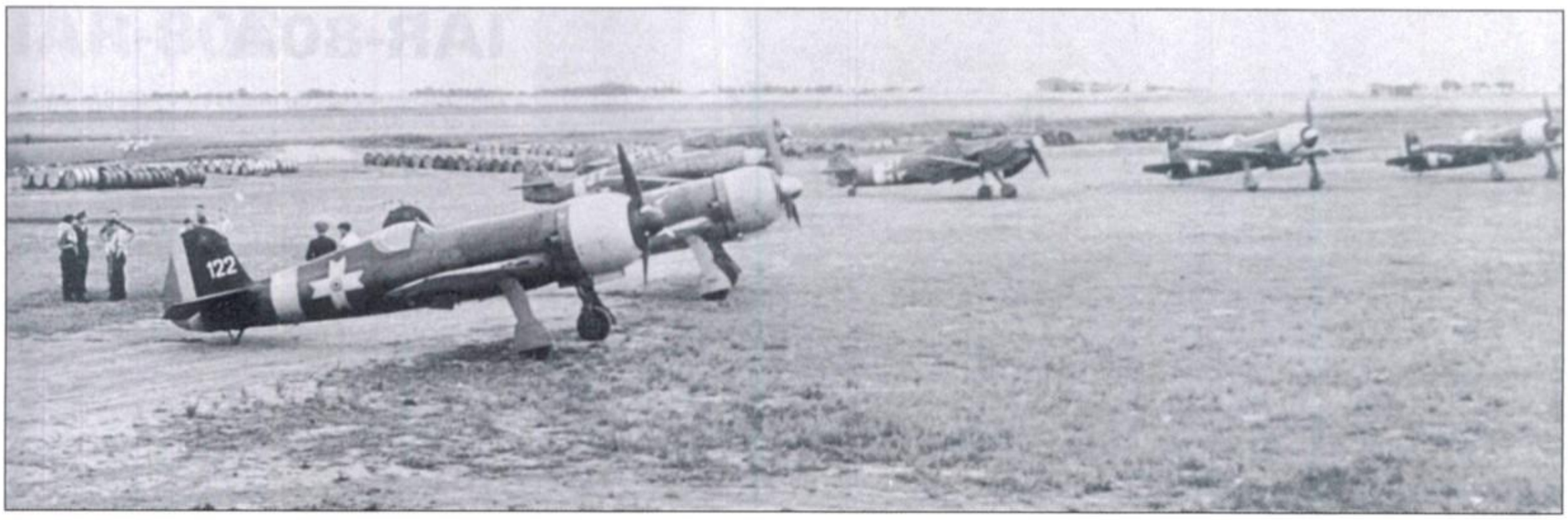


Above: Arrayed in front of hundreds of barrels of aviation fuel at a forward airfield on the Eastern Front are IAR-80As of the Fortele Aeriene Regale Române and Bf 109Gs of the Luftwaffe.

CV-11 was a low-wing monoplane fighter and first flew that same year. However, although it proved to be a sound design, it never entered series production. The next two designs, the IAR-12 and IAR-13, were also never accepted for production, but led to the development of the IAR-14, the first indigenously-designed and -manufactured aircraft to enter Romanian military service. This was followed in 1933 by the more refined IAR-15 and in 1934 by the sole prototype of the IAR-16, both with air-cooled radial engines. The IAR-16 was the first Romanian aircraft to have an all-metal structure, and in 1935 established a national altitude record of 11631 m (38,159 ft). In the mid-1930s, modern fighter aircraft with advanced construction, enclosed cockpits, retractable undercarriages, powerful engines and heavy armament were beginning to enter front-line service with air forces around the world. At that time the backbone of the Romanian air force was the PZL P.11B gull-wing fighter, already well along the road to obsolescence, and a number of older types built by IAR-Brasov and SET in Bucharest. In 1936, the design team at IAR-Brasov offered the Romanian air ministry a preliminary monoplane fighter design featuring an enclosed cockpit and retractable undercarriage. This ill-fated machine was rejected by the Ministry, which had elected instead to purchase the PZL P.24E fighter and acquire a production licence from the Polish firm. Ironically, this was awarded to IAR.

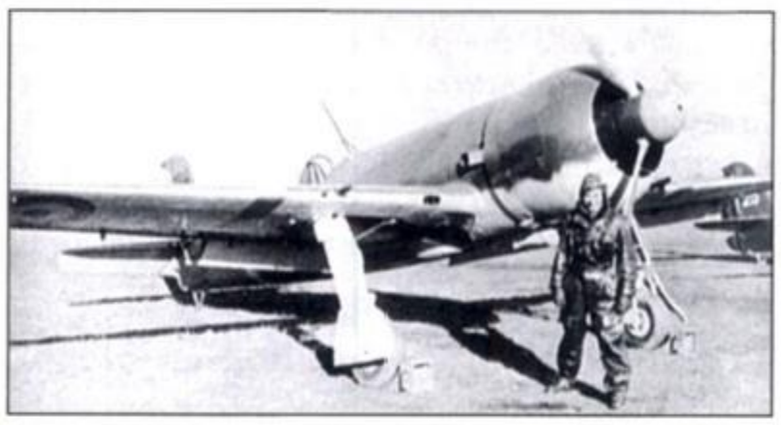
The following year, IAR initiated the development of another indigenous modern fighter as a private venture. The design team was led by Professors Ion Grosu and Ion Cosereanu, Eng. Zotta Gheorghe and Vallner Gheorghe. In order to control development costs, the team decided to use the fuselage and tail section of the PZL P.24, as well as its 870-hp (649-kW) IAR K14 II C32 radial

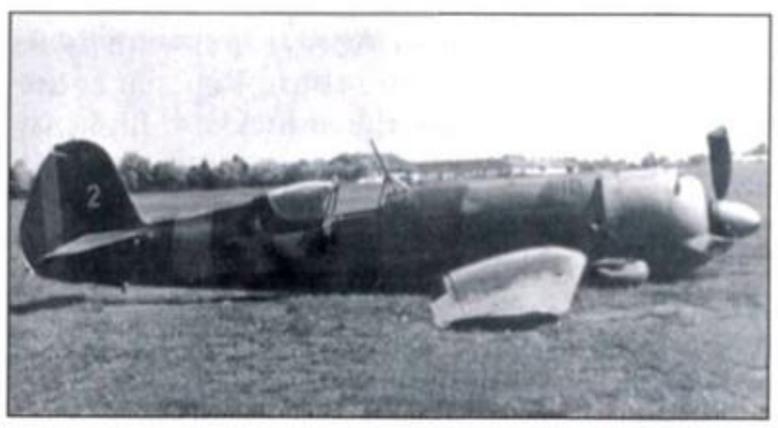
Captain Dumitru 'Pufi' Popescu flew the prototype IAR-80 for the first time in April 1939.

IAR-80

Right: An IAR-80 with the pro-Allied roundel, adopted post-August 1944. By this time most examples of the type had seen considerable action.

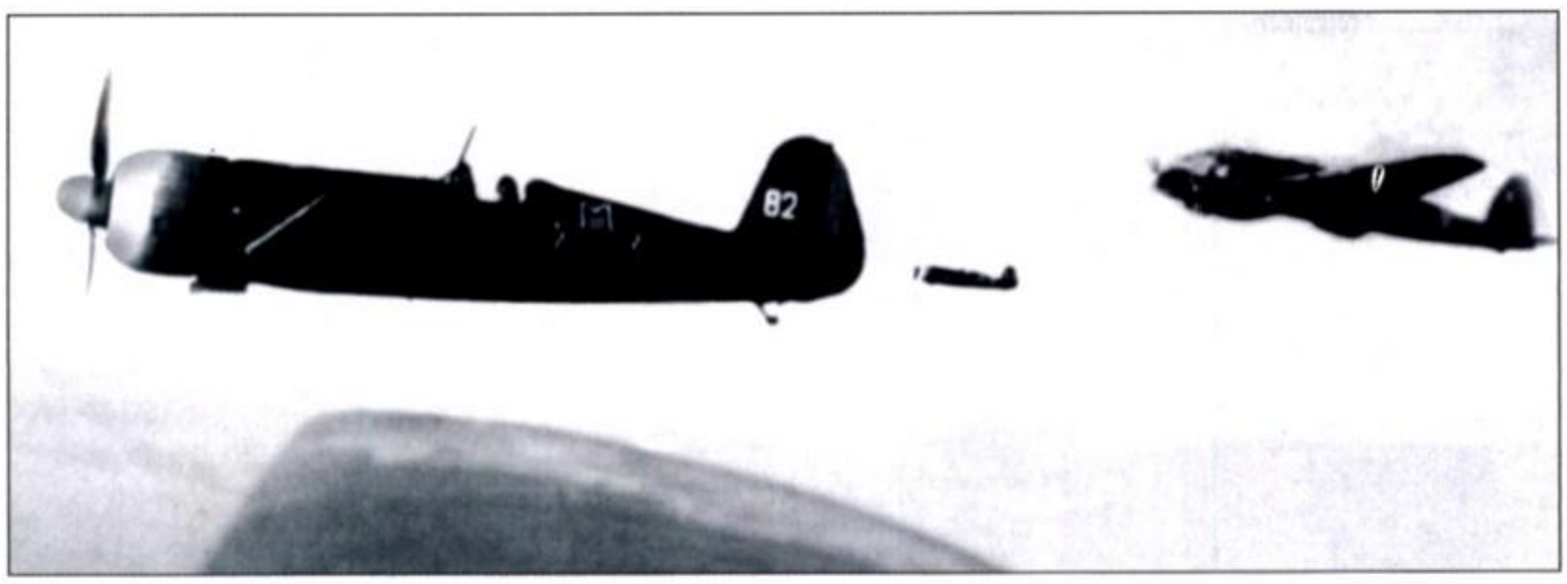
Far right: The second production IAR-80 rests on its belly after a landing accident. The condition of the propeller indicates the engine was running at the time of the incident.





Below right: Two IAR-80s taxi past a parked Regia Aeronautica Macchi MC.200. All have the yellow Eastern Front markings, while the Italian fighter also has white triangles on the leading edge of the wing.

Below: IAR-80 no. 7 formates on the wing of a Romanian air force Heinkel He 111.



IAR-80A

Left: Two IAR-80As on escort duty formate with a pair of He 111Hs during a bombing sortie.

Below and below left: IAR-80As of the Grupul 9 vânātoare (whose green four-leafed clover emblem is visible under the cockpit of each aircraft) are seen at Bucharest-Pipera airfield during the summer of 1942. Each is protected by striped fabric engine covers and camouflage netting, and both have rudder inhibitors. In the left-hand view at least eight other IAR-80s are visible along with a Potez 543 transport.

engine – a Romanian derivative of Gnome-Rhône 14K Mistral Major. The design and the construction of the new aircraft, dubbed IAR-80, required about 60,000 man-hours; metal for a prototype was first cut in the spring of 1938. That September, IAR was nationalised, becoming Regia Autonomã IAR. This brought immediate benefits to the IAR-80 programme in the form of an increase in official support, funding and resources.

First flight tests

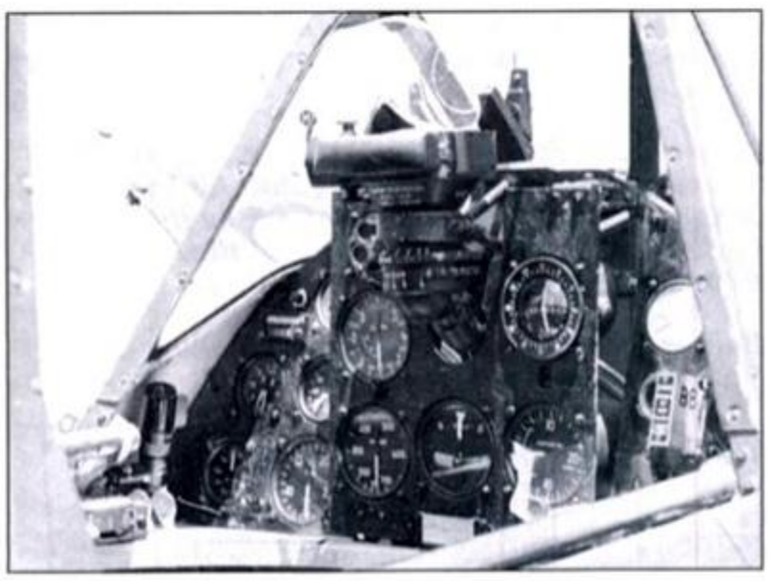
The maiden flight of the unpainted prototype took place at Brasov in April 1939, with IAR test pilot Captain Dumitru 'Pufi' Popescu at the controls. Shortly after the initial test flight, it was decided that the prototype should be transferred to Pipera airfield near Bucharest, for the remainder of the flight test programme. Captain Popescu ferried the aircraft there, where it received a coat of paint and was assigned the number '0', painted in white on the sides of its vertical fin.

The prototype was publicly unveiled on 10 May 1939, during the Romanian National Day military parade held in Bucharest. Because the military authorities decided that the flight tests and evaluations should be made by an experienced, foreign test pilot, the French pilot Michel Detroyat was hired for the job.

While preparing for the first take-off, Detroyat, who was unfamiliar with Pipera airfield, taxied the prototype into some soft ground. The wheels became stuck and Detroyat attempted to power the aircraft out of the mud. After several attempts to free it, the aircraft nosed over into the ground, damaging the VDM three-bladed variable-pitch propeller.

The aircraft was shipped back to IAR-Brasov, where the damaged propeller was replaced by a two-bladed, fixed-pitch wooden propeller. The flight tests were resumed with Romanian test pilots. During the tests, the pilots praised the handling qualities of the new fighter, as well as its high level speed of 510 km (317 mph), comparable with the Hawker Hurricane, Messerschmitt Bf 109 and Curtiss P-36. Conversely, the pilots complained about poor forward visibility during taxiing and considered the aircraft underpowered. The use of a two-bladed, fixed-pitch wooden propeller had done little to improve performance!

The first prototype of the IAR-80 featured an open cockpit and two wing-mounted Browning FN 7.92-mm machine-guns. The prototype had no gunsight, radio equipment or oxygen system, though its main landing gear



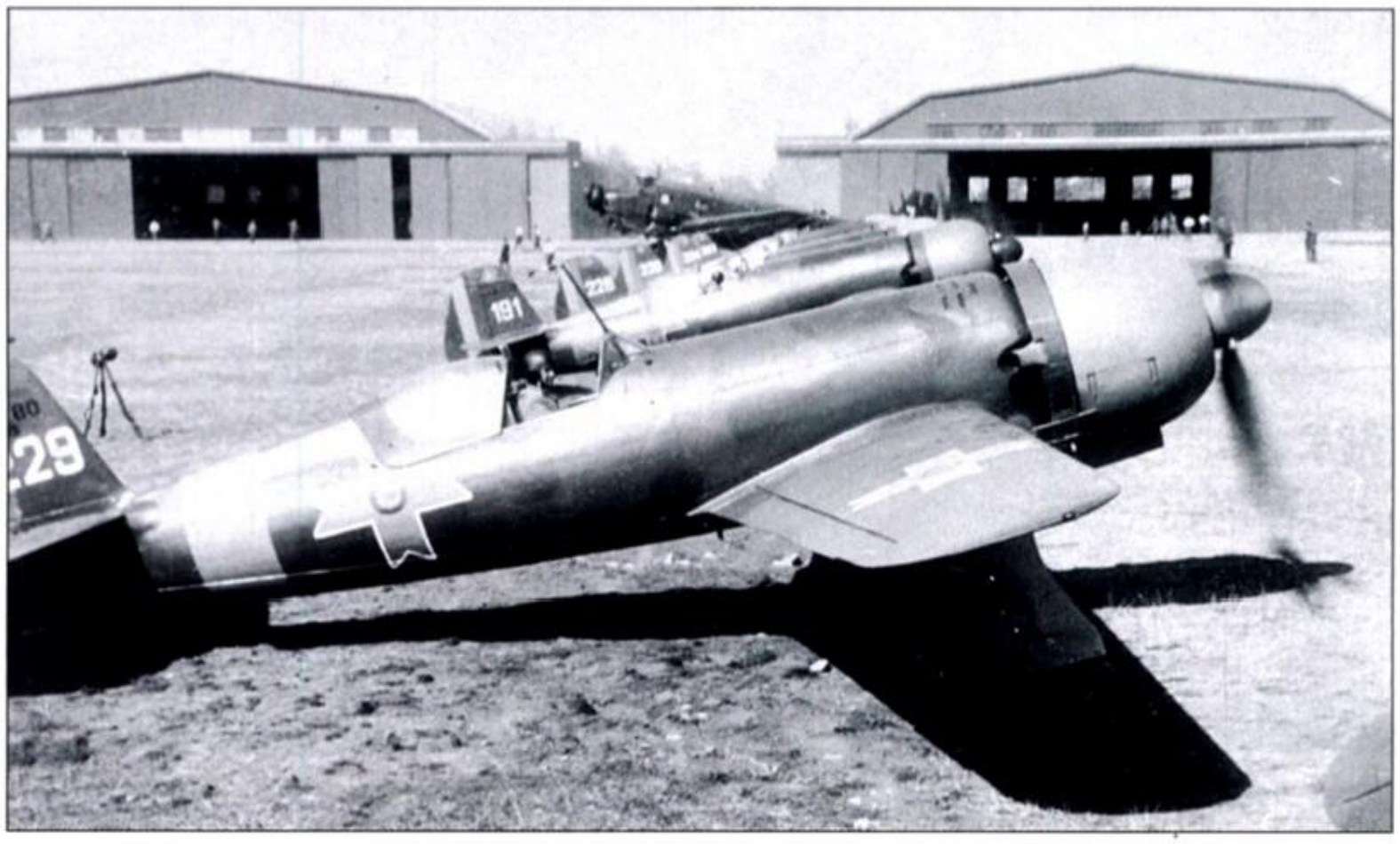
Above: The instrument layout of the IAR-80/81 fighters was dominated by the large reflector gunsight at the top, while the compass on the top right of the panel is instantly recognisable.

Left: Two IAR-80s are seen under construction at the IAR Brasov factory. When opened it was one of the world's largest aircraft production facilities. The first was rolled off the line in February 1940.

IAR-80B

Right: IAR-80B no. 229 and IAR-80 no. 19 are seen on a ferry flight from the Brasov factory to Târgsorul Nou in July 1942. The camouflage scheme and the Axis Eastern Front yellow markings were applied at the factory.

Below right: Engine running, no. 229 heads a line of six IAR-80Bs. The Ju 52/3m (no. 7) in the background belongs to Escadrila 107 transport greu (107th Heavy Transport Sqn).



was fully retractable and sported hinged covers enclosing the entire wheel.

On 18 December 1939 the Romanian government placed an order for an initial batch of 100 aircraft, numbered from 1 to 100. This was followed on 22 August 1940 by a second order for an additional 100 examples. The first production aircraft (no. 1) was completed in February 1940, with the last of the initial batch of 20 (no. 20) following in December.

The production aircraft were fitted with a 960-hp (716-kW) IAR K-14 III C-36 engine, in a slightly modified engine cowling. The cockpit was moved aft and the overall length was increased from 8.16 m (26 ft 9 in) to 8.90 m (29 ft 2 in). The wing span was increased from 10.00 m (32 ft 10 in) to 10.52 m (34 ft 6 in). Standard equipment included a Telefunken FuG VIIa radio and a Munrelle 34 oxygen inhalator. The fully enclosed cockpit was fitted with a modified windshield and an aft-sliding canopy. The rudder area was increased by 1 m^2 (10.76 sq ft), and the tailplane was strengthened, allowing the removal of the bracing struts fitted to the prototype. The undercarriage doors were redesigned and the lower hinged cover was removed, exposing about half of the wheel.

The armament of the first 20 aircraft consisted of four 7.92-mm Browning FN machine-guns, with a total of 2,400 rounds between them.

In service with the FARR

Through Order No. 1590/1941 issued by the Air Staff, Flotila 2 Vânãtoare (2nd Fighter Fleet) – comprising Grupul 1 (1st Group), Grupul 6 (6th Group) and Grupul 8 (8th Group) – was to be the first unit issued with the IAR-80 within the Fortele Aeriene Regale Române (FARR) – the Royal Romanian Air Force. Fifteen pilots from Grupul 1 and a similar number from Grupul 6 were selected for conversion to the IAR-80. On 22 February 1941 the first 20 aircraft were ferried from IAR-Brasov to Târgsor-Ploiesti airfield, where they entered service with the Escadrila 59 (59th Squadron) and Escadrila 60 (60th Squadron), both from Grupul 8. Between 29 March and 5 April the first firing trials were conducted at the range near Constanta, on the shores of the Black Sea. On 15 April Grupul 8 was declared operational and on 21 May the pilots of Grupul 8 began gunnery training at a specially prepared firing range at Târgsor airfield. During the first months of service, two new deficiencies in the aircraft arose. One was related to the upper wheel cover design (a new articulated cover was installed), but more important was the deformation of the fuselage skin behind the cockpit. To correct this, a belt of Duralumin was fitted on the outer surface of the skin, requiring the temporary return of all the aircraft to IAR-Brasov.

Meanwhile, during May 1941, a second batch of 30 aircraft (nos 21 to 50) was delivered, equipped with the more powerful IAR K-14IV C-32, rated at 1,000 hp (746 kW).

On 5 June the Air Staff decided that Grupul 1 should be the second unit to receive the IAR-80. The unit was designated as the operational conversion unit for the IAR-80, under the name Grupul 1 Instructie si Antrenament (Instruction & Training 1st Group).

During this period, the aircraft were painted in a two-tone olive green/brown camouflage scheme, with light blue on the undersides. The national markings were the red/yellow/blue roundels, these being painted on the wings only. The Romanian flag was applied to the rudder. Narrow stripes of red, yellow or blue were painted on the wings and the rear fuselage flanks, indicating the squadron (Escadrila) within a Grupul. These were removed in May 1941, when the engine cowling was painted in yellow and a yellow band was applied on the rear fuselage. On all machines, the aircraft type was shown in black on the fin, while the construction number and the IAR logo were painted in white.

In 1940, though Romania remained neutral, the very existence of the Romanian state was in jeopardy. The Ribbentrop-Molotov Treaty, imposed upon Romania by the USSR, demanded that two old Romanian territories – Bessarabia and northern Bucovina – be ceded to the USSR. With the northwest section of Transylvania partitioned by the Vienna Dictate, and Bulgaria occupying two districts in the south of the Danube Delta, joining the Axis was the only alternative available.

First victory

On 22 June 1941 the Axis forces commenced Operation Barbarossa. Within the Romanian forces, the main FARR offensive unit was Gruparea Aerianã de Luptã (GAL – Air Strike Group), which included Grupul 8 and the IAR-80s of Escadrila 41, Escadrila 59 and Escadrila 60. At the outbreak of the war, of the 58 IAR-80s delivered, three were undergoing repairs. The first air victory credited to the IAR-80 occurred on the first day of war when Adjutant Major Stefan Pucas of Escadrila 59 shot down a Soviet Polikarpov I-16 Rata. Within GAL, Grupul 8 was temporarily assigned to Flotila 1 Vânãtoare (1st Fighter Fleet), initially operating from Focsani airfield, and later from Râmnicu Sãrat. Between 14 and 22 July Grupul 8 operated from Buzãu airfield under the operational command of the Luftwaffe and was charged with oilfield protection. After 22 July, the unit returned to the front and operated from Bârlad airfield, under the overall command of Luftflotte 4.

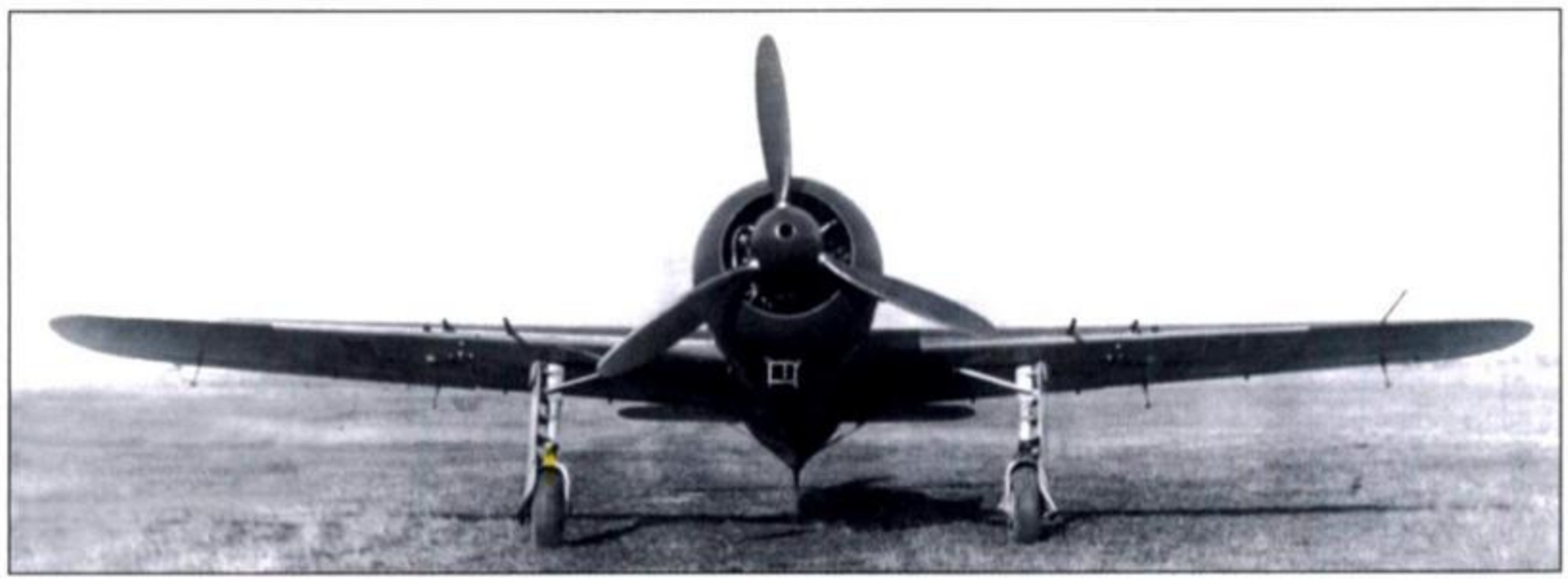
By mid-July, Bessarabia and northern

IAR-80C

Left: Two rows of IAR-80Cs (and IAR-80A no. 108) line up post-war, wearing the pro-Allied white fuselage bands and roundel.

Below left: The harsh conditions on the Eastern Front were a constant enemy of FARR ground crews. Here an IAR-80C is seen having its engine 'thawed out' using a hot air generator, after a bitterly cold night.

Below: The IAR-80C replaced the machine-guns of earlier types with two Icaria/Oerlikon 20-mm cannon. The first 10 (nos 241-250, including this aircraft) were initially laid down as IAR-81Bs and lacked the oil radiator in the left wing root.



Bucovina had been liberated and a portion of the GAL returned to its homeland. During this initial phase of the war, IAR-80 losses amounted to five aircraft in combat and six in accidents. A large number of Soviet aircraft were claimed as destroyed. A photo taken in August of IAR-80 no. 42 of Grupul 8 flown by Adjutant Ion Micu showed 13 aerial victory markings painted on the fin and rudder of the aircraft.

Meanwhile, deliveries of new IAR-80s continued. Aircraft no. 50 was retained by IAR-Brasov for modifications which included the installation of an uprated 1,025-hp (764-kW) IAR K-14-1000A engine, two additional wing-mounted 7.92-mm Browning FN machine-guns, a new armoured pilot seat and a new Goerz reflector gunsight. These changes were soon introduced on the production line, aircraft completed to the new standard being designated IAR-80As. The first batch of 25 IAR-80As (aircraft nos 51 to 75), followed by a second batch of 15 aircraft (nos 76 to 90), were delivered between May and September 1941.

Dive-bomber variant

In 1939, Germany had rejected Romania's request for 50 Junkers Ju 87Bs. The indigenous IAR-37 biplane had proved a failure as a dive-bomber, and the need for a modern front-line aircraft in this role was keenly felt. In response to front-line experience, IAR-Brasov modified aircraft no. 75 with a belly cradle for a 225-kg (496-lb) bomb. Following the installation of the dive-bombing system, the cover of the underwing centre-section was modified to accept wing racks for 50-kg (110-lb) bombs. These racks had been tested previously on aircraft no. 50. To assist in dive recovery, an automatic system extended the flaps to 60°. The landing gear legs were shortened by 7.5 cm (2.9 in), improving forward visibility during taxiing. After factory tests on aircraft no. 75, the modifications were incorporated on the production line, the dive-bomber becoming the IAR-81, dubbed BoPi (Bombardier în Picaj – dive-bomber). Fifteen IAR-81s (nos 91 to 105) were delivered to Grupul 8 from October 1941.

Beginning with aircraft no. 96, the fuselage-strengthening belt installed on previous aircraft was removed, internal reinforcement being provided instead.

Between 18 August and 16 October, the aircraft of the GAL took part in the siege of Odessa. The number of IAR-80s at the front at that time totalled 72, though just 46 were listed as combat ready. On 15 October, Escadrila 59 of Grupul 8 flew the IAR-81's first combat mission.

When the war in Europe began, production of the IAR-80 and IAR-81 was hampered by the interruption of material imports. During the IAR-80's early design and production phase, certain items such as sheet aluminium or the Browning machine-guns were imported, while the landing gear was built under a Messier (France) licence. After the Germans occupied the supplying countries, these deliveries ceased. Starting in early 1941, after Romania joined the Axis, German substitutes were made available to Romania. Late in 1941, the supply of the Browning machine-guns, which were imported from Belgium, became a serious problem. The only solution was to remove the guns from obsolete aircraft (such as the PZL P.11 and PZL P.24 fighters and the IAR-37, -38 and -39 reconnaissance aircraft) and install them in the new machines.

In late 1941 and early 1942, the FARR initiated an immense programme of reorganisation and re-equipment, long overdue and sorely needed. A second batch of IAR-80As (aircraft nos 106 to 150), identical to the first batch with the exception of the fuselage belts, was delivered between October 1941 and May 1942. From this batch, aircraft no. 111 was retained by IAR-Brasov for further factory tests. These aircraft, together with another five (nos 176 to 180) delivered in May 1942, re-equipped Grupul 9 (with Escadrila 47, 48 and 52), Grupul 3 (Escadrila 43, 44 and 50) and Grupul 8 (which now included Escadrila 41, 42 and 60). The older IAR-80s of Grupul 8 were transferred to Grupul 4 (Escadrila 45, 46 and 49) for training purposes. Escadrila 52 and 53 also received IAR-80s. A batch of 25 IAR-81s (nos 151 to 175) re-equipped Escadrilas 61 and 62 of Grupul 6, now designated as a dive-bomber (BoPi) unit.

The GAL, which now included the IAR-80As of Grupul 8 and the IAR-81s of Grupul 6 BoPi under the command of Flotila 2 Vânãtoare, played an active role during the Battle of Stalingrad. Although assigned to dive-bombing duties, the IAR-81s of Grupul 6 BoPi frequently flew fighter missions, while dive-bombing missions were recorded in December 1942.

During the 1941 campaign, the FARR lost 20 IAR-80/81s, while the total for 1942 was 37 aircraft lost both in combat and in non-combat accidents. During the last quarter of 1942, 26 aircraft were lost, most to anti-aircraft fire. A total of 39 Soviet aircraft was shot down.

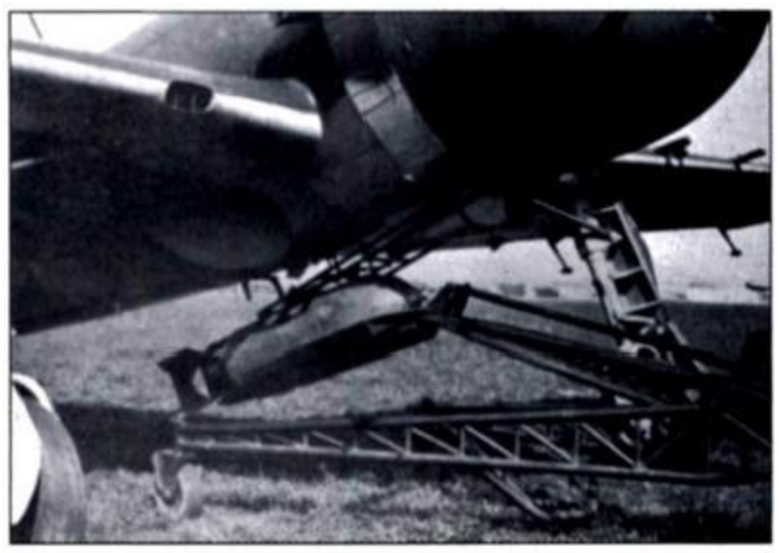
On 31 August 1942 the FARR recorded 152 IAR-80/81 fighters in the inventory, in addition to 48 IAR-81 BoPis. One IAR-80A, no. 111, was retained by IAR-Brasov for further development work. The armour protection was improved and two 13.2-mm calibre Browning FN machine-guns, with 300 rounds each, replaced the two inner wing-mounted machine-guns on the standard IAR-80A. This weight increase required the enlargement of the wingspan to 11.00 m (36 ft 1 in), by the redesign of the wingtip. These modifications were implemented in production as the IAR-80B. Two batches of 20 (nos 181 to 200) and 11 (nos 201 to 211) aircraft, respectively, were built and delivered in June 1942. The latter aircraft had provisions for the installation of 100-litre (22-Imp gal) auxiliary fuel tanks on

IAR-81/A/B

Right: The (mostly bare-footed) ground crews of Grupul 8 are seen checking the engine of an IAR-81 'Bopi' and reloading ordnance somewhere near Zaporozhe in the summer of 1942. Striped fabric covers protect the canopy and engine cowling of the aircraft in the background (almost certainly no. 98).

Centre: These two views show how the IAR-81's centreline bomb cradle was loaded with, and carried, a 225-kg (496-lb) HE bomb. The cradle was necessary to 'fling' the bomb clear of the aircraft's propeller arc in steep dives.

Bottom: The first IAR-81 heads a line-up of similar aircraft (including IAR-81s nos 165, 167, 166 and 100 and IAR-80B no. 239). Each aircraft in the IAR-80 series carried the IAR-Brasov badge on its fin, its type designation beneath and a white-painted individual serial number.



the bomb racks under the wings.

The improvements made in armour protection and firepower resulted in a decrease of the overall performance of IAR-80, and the installation of a more powerful engine was considered. The ideal alternative would have been the BMW 801D, but in 1941 the Germans refused the Romanian request for examples this engine.

The only German engine available in Romania was the Junkers Jumo 211Da, purchased for installation on the JRS-79B bombers. One such engine was temporarily fitted to the IAR-80A no. 111, as was the cowling from the bomber. The aircraft made a single test flight in this configuration in early 1942, with Eng. Alexandru Frim at the controls. Severe vibrations appeared soon after take-off, threatening to shake the aircraft apart. Frim was compelled to shut down the engine and land the aircraft immediately. As a result of this flight, further development of this alternate engine derivative was abandoned.

Aircraft nos 212-230 began production as IAR-81s, but were completed as IAR-80Bs, with structural reinforcements and 350 rounds for the 13.2-mm machine-guns; they were delivered between July and September. Ten aircraft (nos 231 to 240) were built as IAR-81s and were delivered in September. They had provision to carry either the 50-kg bombs or the 100-litre auxiliary fuel tank, and their flap extension for dive recovery was increased to 75°. Two Icaria/Oerlikon 20-mm cannons with 120 rounds replaced the 13.2-mm machine-guns on subsequent aircraft. All the weapons incorporated pneumatic arming, a pneumatic system also being used to operate the cockpit canopy. The tailplane bracing struts were reintroduced. A dust filter was installed on the air intake under the engine cowling. All these modifications were made to aircraft no. 241, the pattern aircraft for the IAR-80C. This aircraft had previously been intended as an IAR-81B dive-bomber (BoPi), but was converted to a fighter for air defence. The first batch of 10 aircraft (nos 241 to 250) was delivered in December 1942, followed by another 40 (nos 251 to 290) with further modifications (self-sealing fuel tanks and a second oil radiator on the left wingroot), delivered between December 1942 and April 1943.

The last batch of 10 IAR-81A dive-bombers (BoPi), nos 291 to 300, was delivered in April and May 1943. The IAR-81A was structurally similar to the IAR-80C, but featured the armament configuration of aircraft nos 212 to 230 and included the provision for the trapeze-launched 225-kg (496-lb) bomb. The increasing need for a modern air defence fighter led to the transformation of the IAR-81C dive-bomber into a modern fighter. The bomb cradle was removed, but the wing racks were retained for the auxiliary fuel tanks. The armament comprised two Mauser MG 151 20-mm cannon with 350 rounds and two Browning FN 7.92-mm machine-guns with 1,400 rounds. A 75-mm (2.95-in) thick windshield was installed, as well as a Romanian Telereflex gunsight.

The IAR-81C was the ultimate version of the IAR-80 to be produced. An initial batch of 100 aircraft (nos 301 to 400) was ordered on May 1942 and was delivered in the second half of 1943. This was followed in 1944 by two smaller batches. Aircraft nos 401 to 435 were delivered between January and March, and aircraft nos 436 to 448 were also confirmed as delivered. Starting in 1943, the FARR passed through another major re-equipment. The older types in the inventory were retired and modern aircraft were acquired on loan from Germany. Grupul 8 Vânãtoare became a ground assault unit as Grupul 8 Asalt with Escadrila 41, 42 and 60, being re-equipped with Henschel Hs 129B-2s. Grupul 4 BoPi, with Escadrila 45, 46 and 49, was re-equipped with IAR-80Cs, while Grupul 9 (with Escadrila 43, 47 and 48) received the IAR-81C. In late 1943/early 1944 Grupul 1 (with Escadrila 63 and 64) and Grupul 2 (Escadrila 65 and 66) also

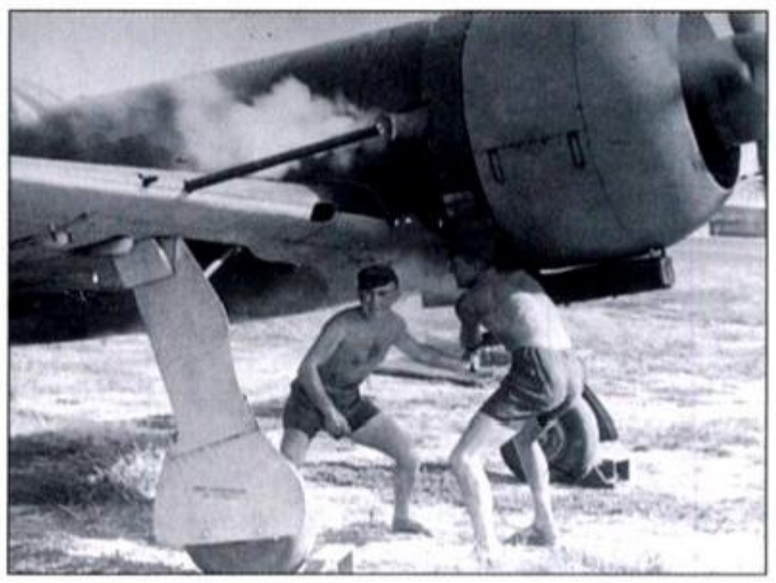
IAR-81C

***Right:** As leather-clad aircrew stand by, an IAR-81C stands with its engine running in snowy conditions. Note the nose artwork, which appears to consist of a deer, on its cowling. The IAR-81C was one of the variants with a strut-braced tailplane.*

***Below:** An IAR-81C is refuelled using a small motorised pump, probably in the summer of 1944. Note the long barrel of the Mauser MG 151 20-mm cannon projecting from the wing with that of the Browning FN 7.92-mm machine-gun outboard.*

***Below centre:** With the pilot in the cockpit to operate the relevant switches, two groundcrew begin to hand-crank the 14-cylinder two-row IAR K-14 radial into life.*

***Below right:** White smoke bellows from the exhaust of an IAR-81C as its IAR K-14 starts. This aircraft has its lower wheel doors – deleted during the winter months as they were frequently damaged on the snow-covered airfields.*



received IAR-81Cs. The main operational unit of the FARR become Corpul 1 Aerian (1st Air Corps).

On the Eastern Front, the IAR-80s were used as fighters, flying cover for bombing raids, as well as for dive-bombing missions. At the outbreak of the war, Soviet aircraft like the I-15 or I-16 had represented the IAR-80's main opposition, but as the war progressed the Soviets fielded new types such as the La-5 and Yak-3, which possessed superior performance to the Romanian aircraft. Although several Soviet aircraft, both fighters and bombers, were shot down by IAR-80s, air superiority was never achieved.

After the re-equipment process had been completed, between early 1943 and April 1944, the IAR-80s flew several combat missions on the Ukrainian front and flew fighter cover missions over the coast of the Black Sea. The first IAR-80s involved in the area were received by Grupul 3 and Escadrila 53 from Grupul 8; later, the IAR-80Cs of Grupul 4 BoPi (with Escadrila 45, 46 and 49) were assigned those missions.

IAR-80/81 losses totalled 12 aircraft in the first half of 1943, from 188 IAR-80/81 fighters and 33 IAR-81 BoPis. In February 1944, the number of IAR-80/81s in service was 302 aircraft, of which only 207 were serviceable.

Fuel produced by the oil refineries of Ploesti was essential for the German war effort. Accordingly, in 1942, the USAAF began air attacks on these vital facilities. The first raid took place on 12 June when 12 B-24 Liberators of the so-called 'Halpro' force took off from Egypt and bombed Ploesti, encountering the IAR-80As of Escadrila 41 of Grupul 8 for the first time. On 1 August 1943 an armada of 178 B-24s of the 98th and 376th BGs, 9th AF and the 44th, 93rd and 389th BGs of the 8th AF took off from the five airfields surrounding Benghazi (Libya) and headed for the oil refineries of Ploiesti. The bombers lacked fighter cover and the bombing run took place from very low altitude. Thirteen IAR-80Bs of the 24 aircraft of Escadrilas 61 and 62, Grupul 4, took off from Pipera airfield near Bucharest. Six of the 12 IAR-80Cs of Escadrila 45, Grupul 4, Flotila 3 (temporarily under the command of Flotila 2) were scrambled from Târgsor airfield.

The IAR-80Bs of Escadrila 61 flew 22 sorties in all, claiming 13 victories (only three of which were confirmed) and losing two aircraft. One of these was no. 222 flown by First Lieutenant Carol Anastasescu. He shot down a B-24, but was hit while attacking a second Liberator. Anastasescu then turned towards another of the bombers, ramming it. The two aircraft separated shortly after the impact and crashed separately. By a miracle, the Romanian pilot survived the crash, and the war.

A total of 53 B-24s was lost, of which 20 were claimed by Romanian fighters and another 15 by the anti-aircraft gunners.

The American bombing raids against Ploesti resumed on 4 April 1944, this time launched from the airfields around Foggia, Italy. Within the joint Romanian/German air defence force protecting Ploiesti were Grupul 2 with Escadrila 58 (Bf 109Gs), Escadrila 65 and 66 (IAR-81Cs) and Grupul 6 (also equipped with IAR-81Cs). Up to mid-May 1944, Grupul 2 claimed 35 victories, plus nine probables, for the loss of six IAR-81Cs and another 13 damaged. On 10 June 1944, 46 bomb-carrying P-38 Lightnings, escorted by another 48 P-38s, of the 1st and 14th Fighter Groups, 15th AF, departed from Siasola and Triola airfields in Italy, and attacked Popesti-Leordeni airfield – the home base of Grupul 6. Twenty-six IAR-80Cs ambushed the American intruders and within 12 minutes 23 P-38s had been shot down, for the loss of two Romanian aircraft in combat plus two in a mid-air collision.

Outclassed by the P-51

When the North American P-51 Mustang was introduced into the theatre as fighter escort, the IAR-81Cs were totally outclassed. On 21 April seven aircraft from the 26 belonging to Grupul 1 were shot down by P-51s. This prompted the removal from air defence duties on 3 July 1944 of the IAR-80/81s, and this task fell to the Bf 109Gs of Grupul 7 and Grupul 9. Most of the airworthy IAR-80/81s were transferred to the Eastern Front, to combat the Soviet forces approaching Romania's borders. The first 90 IAR-80s produced were assigned to Escadrila 44 at Ghimbav near Brasov as fighter trainers. The remaining IAR-80As and all the IAR-80Cs were destined to be brought up to

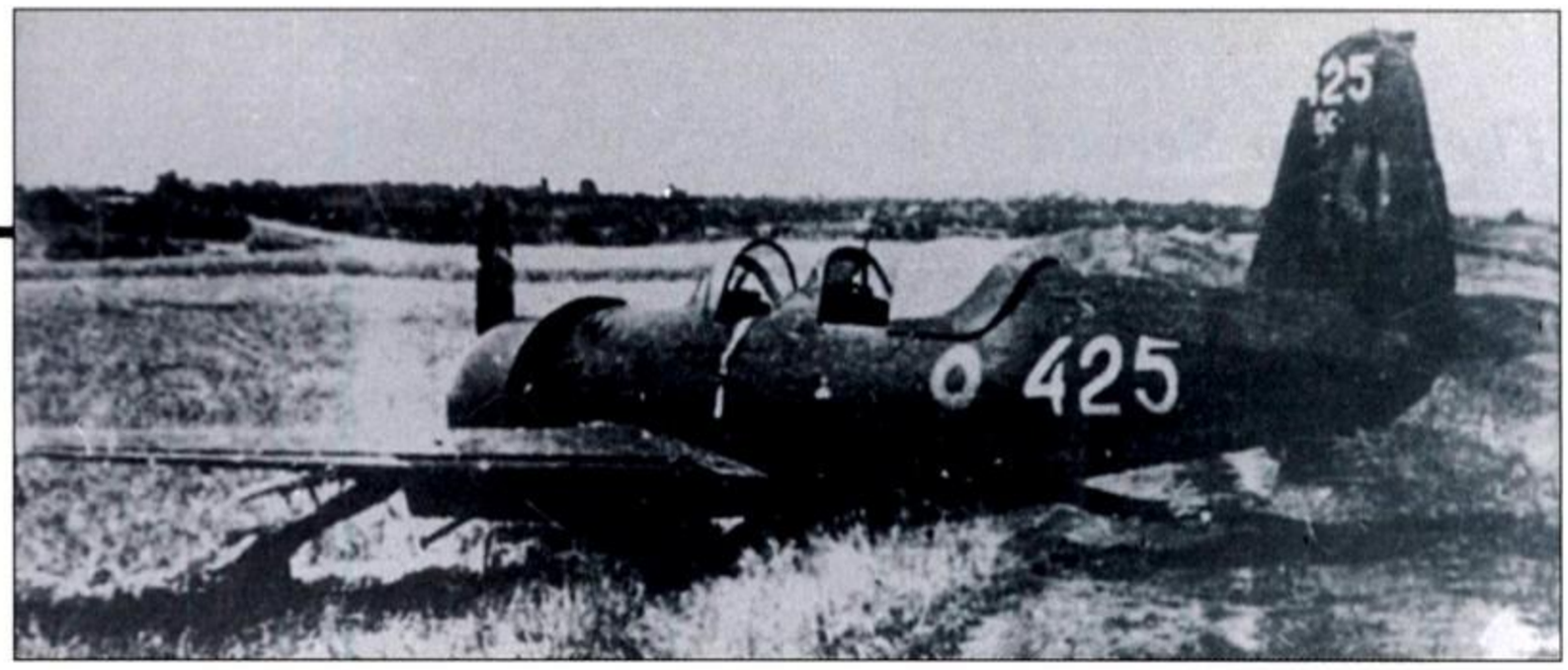
Specification

IAR-80 (Nos 1-50)

Powerplant: one 746-kW (1,000-hp) IAR K-14 C-IV 32 14-cylinder radial engine
Dimensions: length overall 8.9 m (29 ft 2 in); height 3.6 m (11 ft 7 in); wing span 10.52 m (34 ft 6 in); wing area 16.00 m² (172 sq ft)
Weights: empty 2080 kg (4,585 lb); normal take-off 2685 kg (5,919 lb)
Performance: maximum speed at 4000 m (13,123 ft) 510 km/h (317 mph); range 760 km (472 miles); service ceiling 10500 m (34,450 ft)
Armament: four 7.92-mm Browning-FN machine-guns with 2,400 rounds

IAR-81C

Powerplant: one 764-kW (1,025-hp) IAR K-14 1000A 14-cylinder radial engine
Dimensions: length overall 8.97 m (29 ft 5 in); wing span 11.00 m (36 ft) height: 3.52 m (11 ft 6 in); wing area 16.5 m² (177 sq ft)
Weights: empty 2200 kg (4,850 lb); normal take-off 2900 kg (6,393 lb)
Performance: maximum speed at 4000 m (13,123 ft): 500 km/h (310 mph); range 730 km (454 miles) service ceiling 10000 m (32,808 ft)
Armament: two 7.92-mm Browning-FN machine-guns with 1,400 rounds and two 20-mm MG 151 cannon with 350 rounds

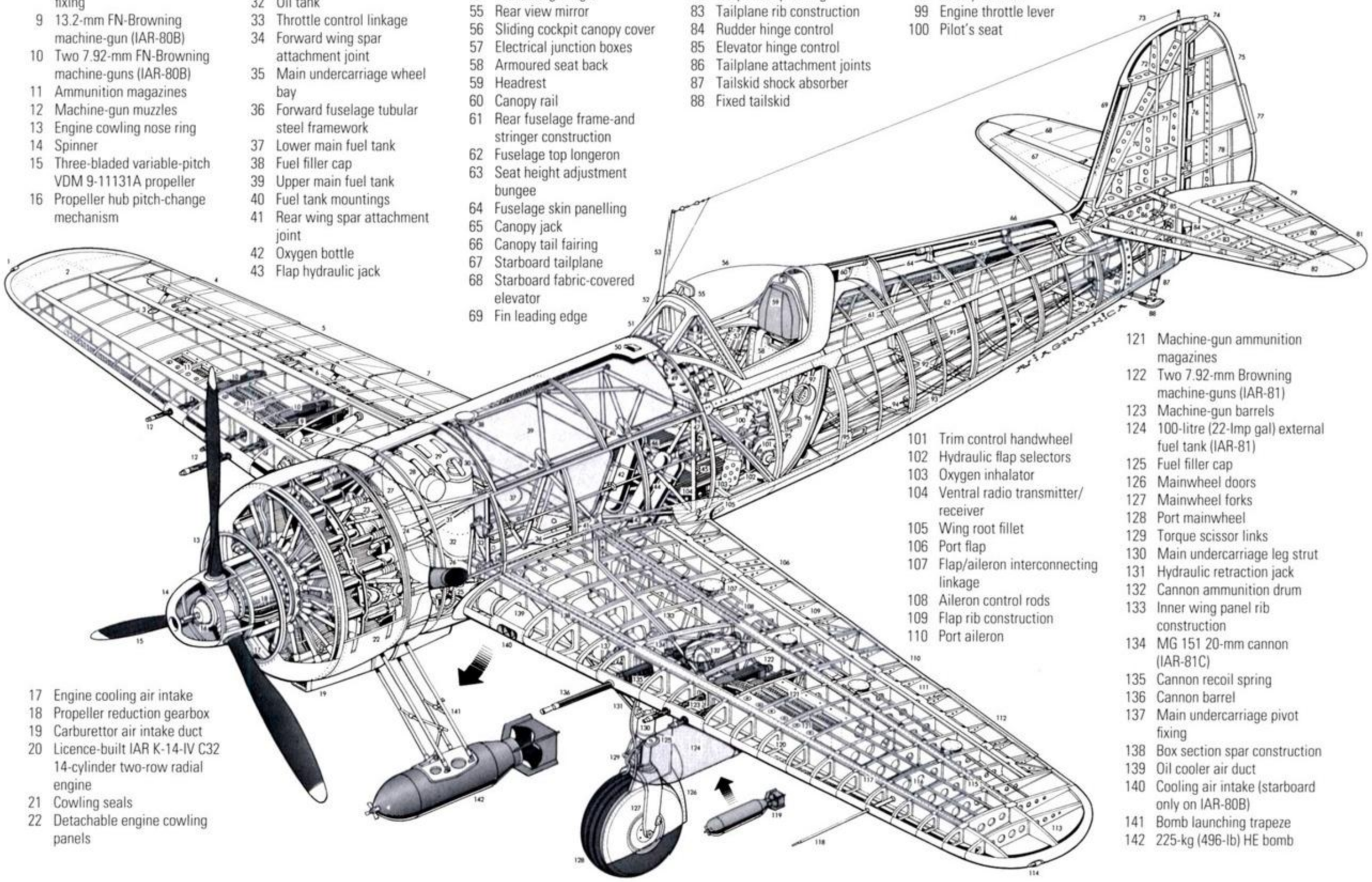


Above: IAR-81C no. 425 was converted as the sole IAR-80DC at Pipera in 1950. The aircraft was withdrawn after this heavy landing.

Right: In an attempt to improve the performance of the IAR-80/81, the Brasov factory test-bed IAR-80A (no. 111) was fitted with an imported Junkers Jumo 211Da 12-cylinder, inverted-vee powerplant. This view, though of indifferent quality, is the only known picture of the converted aircraft.

IAR-80/81 cutaway drawing

1 Starboard navigation light
2 Wing tip fairing
3 Aileron mass balance weights
4 Fixed tab
5 Starboard fabric covered aileron
6 Aileron control linkage
7 Starboard fabric covered flap
8 Main undercarriage leg pivot fixing
9 13.2-mm FN-Browning machine-gun (IAR-80B)
10 Two 7.92-mm FN-Browning machine-guns (IAR-80B)
11 Ammunition magazines
12 Machine-gun muzzles
13 Engine cowling nose ring
14 Spinner
15 Three-bladed variable-pitch VDM 9-11131A propeller
16 Propeller hub pitch-change mechanism
17 Engine cooling air intake
18 Propeller reduction gearbox
19 Carburettor air intake duct
20 Licence-built IAR K-14-IV C32 14-cylinder two-row radial engine
21 Cowling seals
22 Detachable engine cowling panels
23 Engine accessory equipment compartment
24 Exhaust collector
25 Oil cooler
26 Port exhaust duct
27 Engine cowling air flaps
28 Oil recuperator
29 Cooling air vents
30 Oil filler cap
31 Engine bearer struts
32 Oil tank
33 Throttle control linkage
34 Forward wing spar attachment joint
35 Main undercarriage wheel bay
36 Forward fuselage tubular steel framework
37 Lower main fuel tank
38 Fuel filler cap
39 Upper main fuel tank
40 Fuel tank mountings
41 Rear wing spar attachment joint
42 Oxygen bottle
43 Flap hydraulic jack
44 Compressed air bottles (gun firing)
45 Footboards
46 Rudder pedal bar
47 Control column
48 Control column handgrip
49 Instrument panel
50 Fresh air intake
51 Armoured glass windscreen panel
52 Aerial lead-in
53 Aerial mast
54 Reflector gunsight
55 Rear view mirror
56 Sliding cockpit canopy cover
57 Electrical junction boxes
58 Armoured seat back
59 Headrest
60 Canopy rail
61 Rear fuselage frame-and stringer construction
62 Fuselage top longeron
63 Seat height adjustment bungee
64 Fuselage skin panelling
65 Canopy jack
66 Canopy tail fairing
67 Starboard tailplane
68 Starboard fabric-covered elevator
69 Fin leading edge
70 Diagonal fin spar
71 Fin rib construction
72 Fin tip fairing
73 Aerial cable
74 Tail navigation light
75 Rudder
76 Rudder hinge post
77 Fixed tab
78 Rudder rib construction
79 Elevator trim tab
80 Elevator rib construction
81 Port elevator
82 Tailplane tip fairing
83 Tailplane rib construction
84 Rudder hinge control
85 Elevator hinge control
86 Tailplane attachment joints
87 Tailskid shock absorber
88 Fixed tailskid
89 Tailplane attachment fuselage main frame
90 Lifting tube
91 Rudder control cables
92 Elevator 'push-pull' control rod
93 Fuselage bottom longeron
94 Trim control cables
95 Boarding steps
96 Diagonal cockpit section framing
97 Oxygen regulator
98 Safety harness
99 Engine throttle lever
100 Pilot's seat
101 Trim control handwheel
102 Hydraulic flap selectors
103 Oxygen inhalator
104 Ventral radio transmitter/receiver
105 Wing root fillet
106 Port flap
107 Flap/aileron interconnecting linkage
108 Aileron control rods
109 Flap rib construction
110 Port aileron
111 Aileron rib construction
112 Fixed aileron tab
113 Wing tip fairing construction
114 Port navigation light
115 Rear spar
116 Outer wing panel rib construction
117 Front spar
118 Pitot head
119 110-lb (50-kg) HE bomb (IAR-81)
120 Leading edge nose ribs
121 Machine-gun ammunition magazines
122 Two 7.92-mm Browning machine-guns (IAR-81)
123 Machine-gun barrels
124 100-litre (22-Imp gal) external fuel tank (IAR-81)
125 Fuel filler cap
126 Mainwheel doors
127 Mainwheel forks
128 Port mainwheel
129 Torque scissor links
130 Main undercarriage leg strut
131 Hydraulic retraction jack
132 Cannon ammunition drum
133 Inner wing panel rib construction
134 MG 151 20-mm cannon (IAR-81C)
135 Cannon recoil spring
136 Cannon barrel
137 Main undercarriage pivot fixing
138 Box section spar construction
139 Oil cooler air duct
140 Cooling air intake (starboard only on IAR-80B)
141 Bomb launching trapeze
142 225-kg (496-lb) HE bomb



These four views of IAR-80C operations on the Eastern Front, are believed to have been taken in 1943. Note the distinctive red/white spinner pattern, applied to identify the aircraft as subordinate to Luftflotte 4.

IAR-81C standards with the installation of Mauser 20-mm cannon, and were redesignated IAR-80M and IAR-81M, respectively. The process started in early 1944, but only 11 aircraft had been converted by war's end. The major shortcoming of the IAR-80/81 in combat was the installation of the fuel tanks ahead the cockpit. Several pilots suffered serious burns during combat when the fuel tanks were hit. One IAR-81C was tested in the summer of 1944 with a pair of wing-mounted 210-mm Werfer Granate 21 mortars for the anti-bomber role, but this weapon was not used in combat.

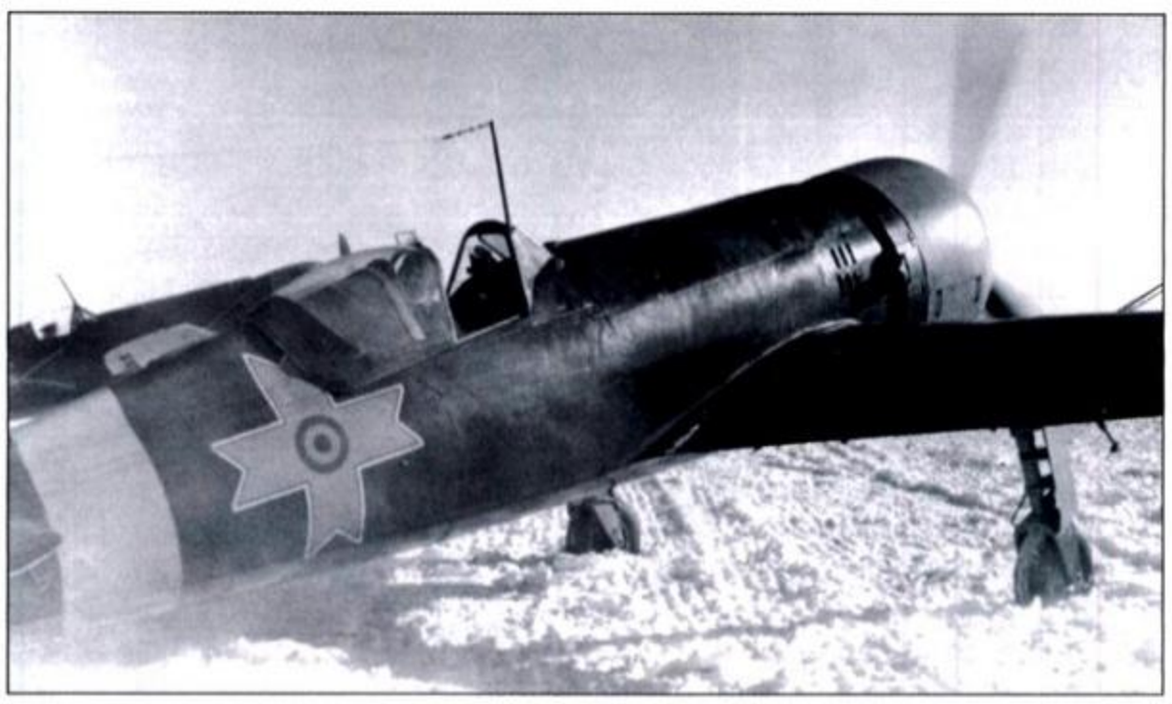
The first bombing raids against the IAR factory in Brasov took place on 6 May 1944. On 4 July the IAR factory was attacked and partially destroyed by a force of approximately 250 Liberators. This raid signalled the end of IAR-81C production. Two aircraft, nos 449 and 450, were destroyed prior to delivery and another 11, nos 451 to 461, were destroyed on the production line. However, by this time the FARR had decided to replace the IAR-81 with the licence-built Bf 109G (though the Messerschmitt was destined never to be built in Romania).

Between May 1941 and September 1944, the military insignia of the FARR was a yellow cross made from four stylised Ms, outlined in blue with a small red-yellow-blue roundel in the middle. The undersides of the wingtips were painted yellow, and the yellow fuselage band was widened and moved aft. During this period, some IAR-80s sported nose art, representing squadron emblems or personal markings. Some aircraft wore a white triangle under the cockpit.

On the Western Front

On 23 August 1944, a coup d'état replaced the pro-German government of Antonescu and Romanian loyalty switched to the Allies.

In late August a total of 57 IAR-81Cs was in the inventories of Grupuls 2 and 6, while older aircraft were serving with Escadrila 44 at Ghimbav. During the liberation of western Romania, there were a few dogfights between Romanian IAR-80/81s and German Fw 190As and Bf 109s. Forty-seven IAR-81Cs continued the fight with Grupul 2 (Escadrila 65 and 66) within Corpul Aerian – the commanding



authority of the FARR during the Western campaign. Corpul Aerian was placed under the authority of the 5th Soviet AF. The IAR-81Cs of Grupul 2 operated from Someseni airport near Cluj until 26 October, from Turkeve in Hungary until 20 December, and then moved to Miskolc in Czechoslovakia until the end of operations on 12 May 1945. After that, the aircraft were returned to Romania and were used for advanced training. During the Western campaign, from 5 September 1944, the King Michael's Cross national marking was replaced with the pre-war roundel, the yellow Axis identity bands on the wingtips and aft fuselage were replaced with white ones, and the upper surfaces were painted olive-green overall.

Epilogue

Although Romania fought on the Allied side during the last nine months of the war, it was treated as a defeated nation and became a part of the Soviet sphere of influence, and soon became a Communist country. What remained of the IAR factory was gradually converted to an engine overhaul plant. In 1946, the factory was converted to the production of tractors and was renamed Sovromtractor in July 1947. Ironically, the first tractor type was named IAR-22, after a sport aircraft built in the 1930s by IAR. The provisions of the peace treaty prohibited Romania from producing combat aircraft. Production facilities were either destroyed or dismantled and sent to the repair centre established at that time (ARMV-2 in Pipera near Bucharest, later to URA in Bacau).

The surviving IAR-80s and IAR-81s remaining in service as fighter trainers were gradually replaced, initially by the Bf 109Gs built from components remaining from wartime production, then from 1949 by Lavochkin La-9s and Yakovlev Yak-11s.

In 1950, the colour scheme and the military insignia of Romanian air force aircraft was changed once again. The aircraft were repainted and the white bands on the wingtips and fuselage were removed, as were the factory logo and aircraft type from the fin. The Romanian national colours on the rudder were also removed. The new military insignia, a Soviet-style red star with yellow and blue roundels in the centre, was painted on the wings, fuselage sides and the fin. The aircraft number (actually the factory number) was painted on the fuselage sides.

Also in 1950, the conversion of IAR-81C no. 425 into a two-seat trainer took place at what was to become (in 1951) ARMV-2 (ARMV – Atelierul de Reparatii Material Volant/Flying Material Overhaul Workshop) in Pipera, near Bucharest. The IAR-80DC (Dublã Comandã – two-seater) had an open second cockpit inserted in front of the original one. The fuel capacity was greatly reduced, flight endurance being limited to 25 minutes. The sole aircraft so modified ended its career after a heavy landing during which the landing gear was damaged beyond repair.

The last IAR-80/81s were retired in 1952. All remaining aircraft were scrapped and, sadly, none was saved for preservation. Only a few engines (possibly four) have survived at Iasi and Bucharest, along with a few instruments. In 1987, a few technical manuals and around 15 per cent of the manufacturing documentation was discovered at IAv Bucharest (now Romaero SA), which evolved from ARMV-2.

Above: The IAR-81C was the last version of the IAR-80 series built. Outclassed as a fighter by mid-1944, the lack of Bf 109Gs in sufficient numbers forced the type to be retained in service. This example is the 69th of 161 built (a further 13 being destroyed when the IAR factory was bombed).

Below: This worn IAR-80, belonging to Escadrila 59 vânãtoare, was based at Turnisor airfield in the Transylvanian Theatre of Operations during early October 1944. It wears pro-Allied roundels and a (peeling) white fuselage band. Two VVS (Soviet air force) Po-2s rest behind the IAR-80.

The construction of a full-scale replica of the IAR-80 was started at ICA Ghimbav (now IAR SA) in late 1987 and was completed in mid-1988. It was put on display at the Central Military Museum (renamed National Military Museum after 1990) later that year. The replica represents IAR-80 no. 42, painted in the markings worn during the Western campaign. This aircraft was credited with 13 air victories at the beginning of the campaign and was still in good condition within Escadrila 44 when the war against the Axis ended. Due to the tendency of Communist leaders to minimise the waste of materials and finances, the replica was simplified and proved to be inaccurate in details. Also displayed with the replica is the tailplane and engine cowling of IAR-81C no. 426, shot down on 21 April 1945 near Vilcnov, in Czechoslovakia. A Czechoslovak citizen offered the parts to the museum.

In late 1995, the construction of a second and more accurate replica of an IAR-80 was started at IAR S.A. Ghimbav-Brasov. This represented the first production aircraft – no. 1 – and was painted in the colours worn during the Eastern campaign. The aircraft was put on display at the Muzeul Aviasiei (Aviation Museum) at Bãneasa Airport on 20 July 1996. Today, the museum section at Bãneasa is being transferred to Otopeni, where the replica awaits the museum re-opening. **Danut Vlad**

Two IAR-80 replicas have been constructed, the first of which (representing no. 42, above) was completed in 1987 for the Central Military Museum. More recently a more accurate example (below) has been constructed by IAR S.A. at Ghimbav-Brasov. This represents the first production IAR-80.

'Screaming Bird'

B-57 Canberra operations in Vietnam, 1963-72

A night-intruder derivative of a British design, Martin's B-57 Canberra played a comparatively unsung part in the air war over Vietnam. Nevertheless, it was the first American jet bomber to drop bombs in anger and, in its basic B-57B form, performed solidly between 1963 and 1969. In the B-57G it attained a 'real' night-intruder capability, pioneering the use of electro-optical targeting sensors and LGBs, while the Patricia Lynn RB-57E was among the most capable reconnaissance platforms of the war.

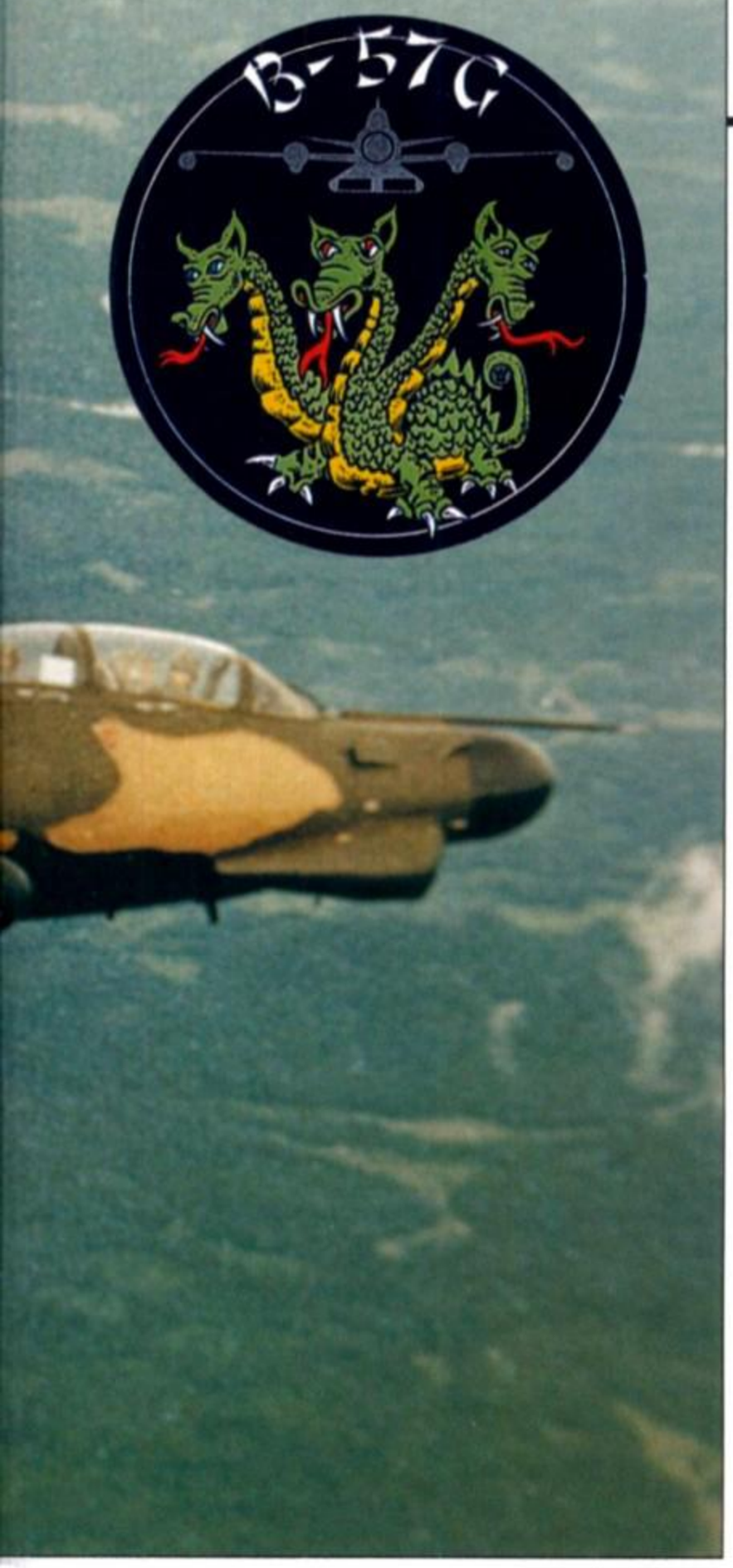
Combat for the American B-57 Canberra crews did not begin well. From the time these crews were alerted for Vietnam duty to when the first bombs were dropped, they were regarded by some as the 'unlucky squadrons' due to a string of unpleasant events.

This began with the abrupt disruption of private lives as families did not know whether they would move back to the United States, remain at Yokota AB, Japan, or move with the units to Clark AB, Philippines. Just as this was resolved and morale was again on the upswing, a devastating training accident took the lives of two highly qualified and well-liked pilots. Before long, two more crew members died in a crash in a multiple accident, destroying two Canberras and damaging a third. A few weeks later, a night mortar attack among 20 B-57s parked at Bien Hoa AB in Vietnam ruined five Canberras, damaged 15 others, killed four Americans and wounded 72. The situation was made more difficult because, for political reasons, the B-57s at this point were not allowed to directly participate in combat.

The story of the B-57 Canberras' involvement with the war in Southeast Asia began after the parent unit, the 3rd Bombardment Wing, was transferred on paper to the United States. The 90th Bombardment Squadron soon followed. The 8th and 13th Bomb Squadrons were to follow, but the war situation prevented this transfer and left the two squadrons in a state of limbo, not knowing if they, too, would be reassigned, disbanded or drawn into a war that showed strong signs of escalating.

It was the fate of the two remaining B-57 bombardment squadrons, with 45 Canberras, to be kept intact and moved from Yokota AB to Clark AB in the Philippines in April 1964. Competitions in bombing and gunnery accuracy

3rd Bomb Wing B-57B Canberras had stood nuclear alert duties at Kunsan (K-8), Korea for five years when they were called back to their home base at Yokota, Japan (seen here) on 2 April 1964. A new and all too real period of duty was about to begin in the dangerous skies over Vietnam.



Above: It was not until the advent of the heavily modified B-57G in 1970 that the Canberra could claim to be a fully mature night-interdiction platform. The B-57Gs all flew with the 13th BS from Ubon AB, Thailand.

Below: Thanks to its impressive capabilities and the dedication of its air and ground crews, the Canberra managed to achieve a reputation for combat effectiveness out of all proportion to the number of aircraft deployed. Here pilot Bill Height and navigator Robert Maiden are seen in different positions around their 8th BS B-57B, thanks to multiple-exposure photography during a pre-flight inspection at Phan Rang.

8th BS, 3rd BW B-57Bs from Yokota AB turn towards the Mito Gunnery Range on a practice strafing mission. The combat readiness of the Yokota crews was high even before the initial deployment to Bien Hoa.

showed these crews to be well trained and an asset in the developing combat situation. They were assigned to the 405th Tactical Fighter Wing which comprised three F-100 squadrons, now with two bomber squadrons added. Members of these two squadrons with more than a year retainability for their three-year overseas assignments were allowed to move their families to Clark AB if they wished, and many of them did.

Readiness training for the B-57 crews continued at a steady pace, even though the crews had left Japan already highly proficient. They continued practice with air-to-ground gunnery and rocketry, skip and dive bombing, as well as SHORAN (short-range aerial navigation) bombing, a form of level, high-altitude bombing by automatic radio triangulation.

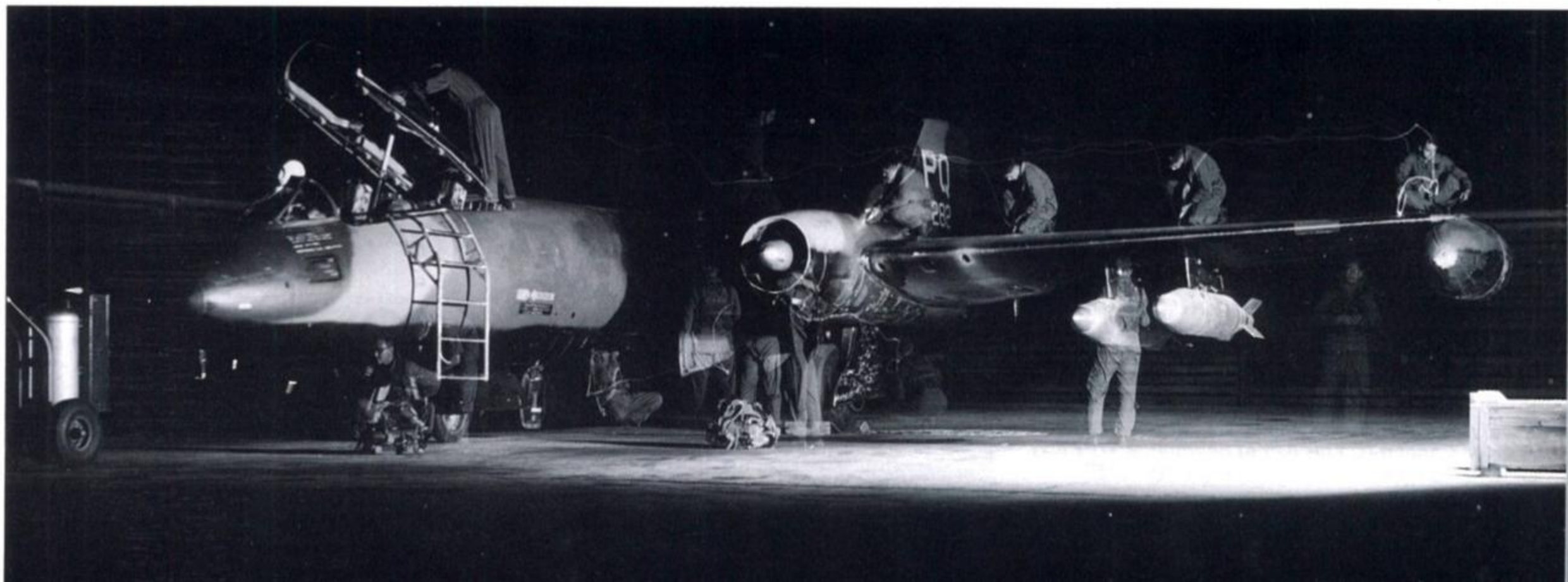
An outstanding safety record was severely marred on 4 June at the Crow Valley Gunnery Range used by the B-57s, when two experienced Canberra pilots, Carl Bratton and John Bass, crashed during a gunnery pass. The cause remained unresolved, and the deaths were a severe blow to the morale of the two squadrons.

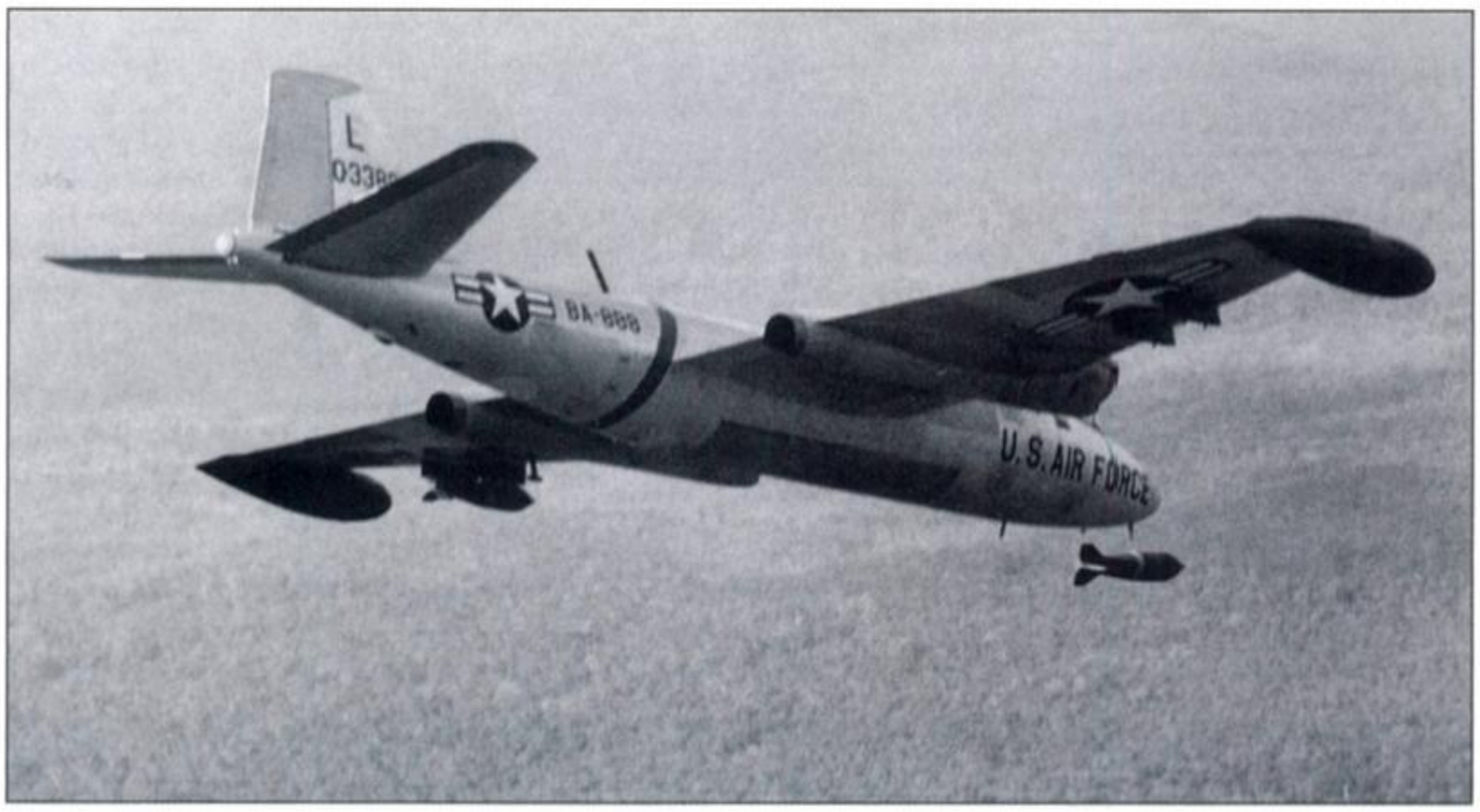
The nerves of the B-57 crews were stretched taut as the war in Vietnam escalated. After the Tonkin Gulf Incident of 2 August 1964, Clark AB changed to a 24-hour wartime atmosphere. Fighter units were deploying, air transports were lifting supplies day and night, yet the two B-57 squadrons were held on ready standby. Should they be called into the war, their forward base would be either Takhli Air Base, Thailand, or Bien Hoa – an airfield about 10 miles (16 km) northeast of Saigon. The B-57 crews grew anxious, knowing that something was going to happen – but what, and when?

The call to Bien Hoa

After four months of agonised waiting for action at Clark, on 4 August 1964, just before midnight, an alert notice was received to prepare the two B-57 squadrons for deployment. Everyone was 'spring loaded', but by early morning disappointed crews were told to return to their quarters to again stand by for further information. They were anything but relaxed. By that evening, the movement order came by message ordering 20 B-57s to depart for Bien Hoa Air Base as soon as possible. Crews had already been assigned and had checked their aircraft, and now flight plans to this newly announced destination were hastily prepared for the five flights of four aircraft each. The first flight took off at 19.00 and succeeding flights launched at 20/30-minute intervals.

As the hours of the day had dragged by without a word, it was taken into consideration that the deployment might be made at night. Few of the crews had ever flown night formation, as it had not been a B-57 combat





B-57B, 53-3888, achieved the distinction of being the first US jet bomber to drop bombs in combat. The aircraft belonged to the 13th BS and carried the callsign RED LIMA. It is pictured (top right) at Bien Hoa in February 1965 and (above and top) during its historic mission. It is clear from the photographs that the first bomb to fall from a US jet bomber in combat was a 750-lb M117 (two were carried beneath each wing). The photograph immediately above was taken as the third bomb to fall was en route, while it can also be seen that a fourth M117 and nine 500-lb GPs would also soon be falling on the heads of the Viet Cong in the jungle below.

Right: Road reconnaissance and a simple show of force were the original taskings of the Bien Hoa Canberras. This pair of unarmed B-57Bs was making its presence felt over a stretch of the Mekong River.

crew training requirement. Regardless, the departure and form-up into flights of four was executed well by these experienced pilots. It was at the other end that problems soon developed.

Bien Hoa was an unfamiliar field for most of the crews, especially with added restrictions caused by darkness and the 700-ft (213-m) ceiling in monsoon weather. Uncertainties after landing caused one aircraft to delay on the runway, so that another, suffering from loss of hydraulic brake pressure, overtook and collided with it in the darkness. One Canberra was a write-off, although, after much work, the second aircraft was repaired. Adding insult to injury, another B-57 blew both tyres on its landing roll, which further tied up the runway. Fortunately, there were no injuries from these mishaps.

The remaining B-57s converging on Bien Hoa had to be diverted to Tan Son Nhut, 8 miles (13 km) southwest. Deviations from intended flight plans while en route can create a bad situation, especially at night and with so many aircraft involved. For reasons which were never satisfactorily determined, Captain Fred Cutrer and his navigator, Lieutenant Kaster, crashed a few miles short of the runway at Tan Son Nhut while on a straight-in TACAN approach. This crash site was in a heavily populated VC area and was considered a combat loss. It took weeks before a diversionary force and a sizable main force could be staged to retrieve their bodies from the crashed aircraft.

As is apparent, the beginning was not auspicious for B-57 operations in Southeast Asia. Investigation into these mishaps traced the root of the problem to the movement order and the interpreted meaning of 'as soon as possible'. In a wartime situation, most commanders would construe this to mean 'now', while in a peacetime atmosphere it would imply movement after proper crew rest, and under suitable flying conditions commensurate with training received. Needless to say, subsequent messages of this type were given closer scrutiny after this deployment.

A fighting force of B-57s was now in the combat zone and ready for action at Bien Hoa, but it would be seven months before the Canberras would be given an active role in

Wing guns
A pair of 20-mm M39 cannon in each wing ensured that the B-57B packed a heavy punch for strafing attacks. Each weapon was supplied with 290 rounds of ammunition, adding to the B-57's remarkable combat persistence.

Underwing bombload
Four 750-lb M117 GP bombs were carried underwing, along with a belly full of additional weapons, on the first historic strike. Canberra load-outs remained relatively unchanged for the duration of the type's combat duty.

Martin B-57B Canberra
13th Bomber Squadron, 6251st Tactical Fighter Wing
Bien Hoa AB, 1965

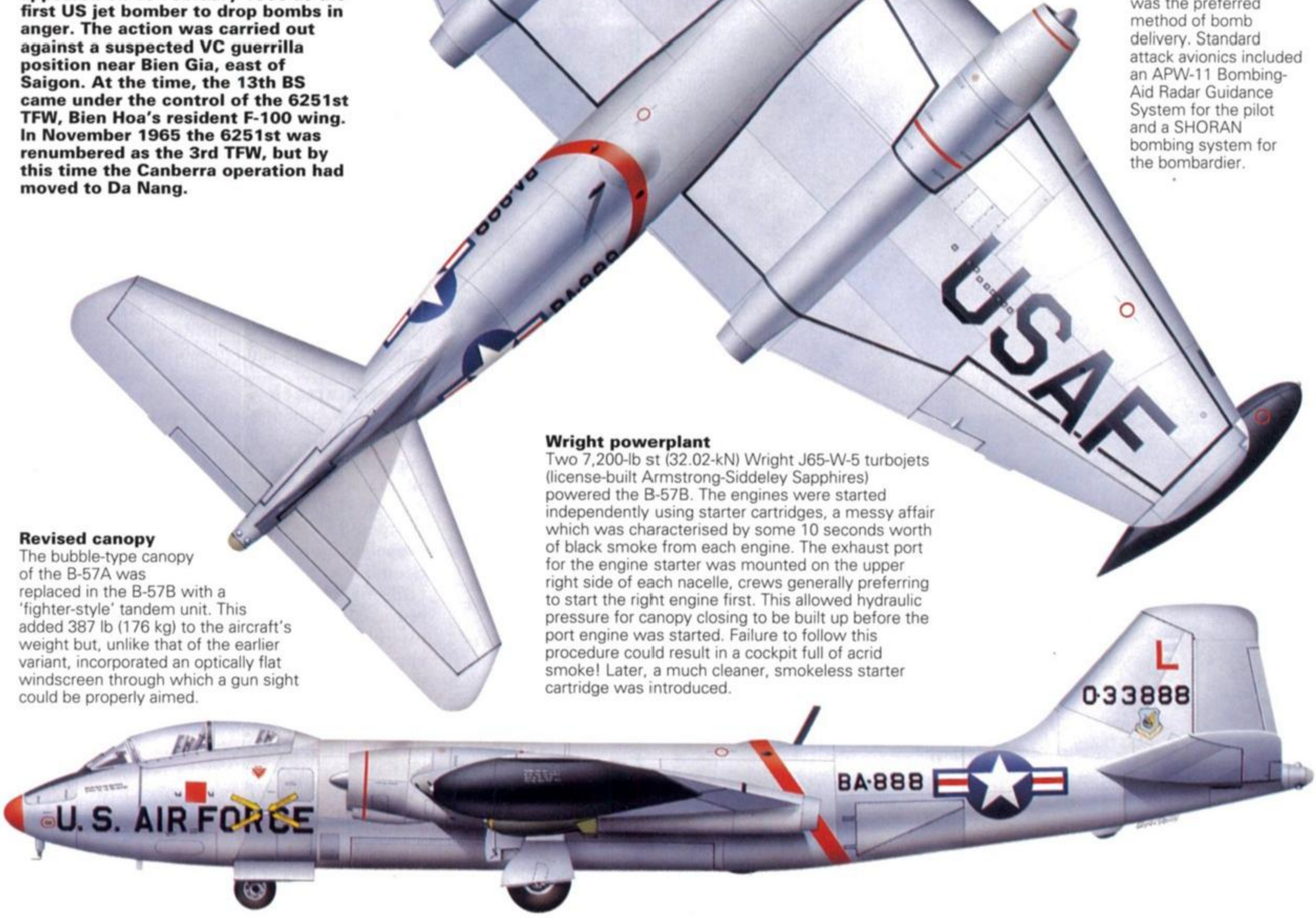
Fuel system
Fuel for the Wright turbojets was drawn from six tanks. These consisted of one 1,010-US gal (3833-litre) main fuselage tank, one 662-US gal (2506-litre) auxiliary fuselage tank, two 580-US gal (2196-litre) outer wing fuel tanks and two 640-US gal (2423-litre) tip tanks. The later could in theory be jettisoned in flight, but in practice never were. The total fuel load of 4112 US gal (15577 litres) gave the Canberra an endurance to match its huge weapon load and added mightily to the enemy's perception of the aircraft as one of America's most hated and feared warplanes.

B-57B 53-3888 is illustrated as it appeared on 19 February 1965 as the first US jet bomber to drop bombs in anger. The action was carried out against a suspected VC guerrilla position near Bien Gia, east of Saigon. At the time, the 13th BS came under the control of the 6251st TFW, Bien Hoa's resident F-100 wing. In November 1965 the 6251st was renumbered as the 3rd TFW, but by this time the Canberra operation had moved to Da Nang.

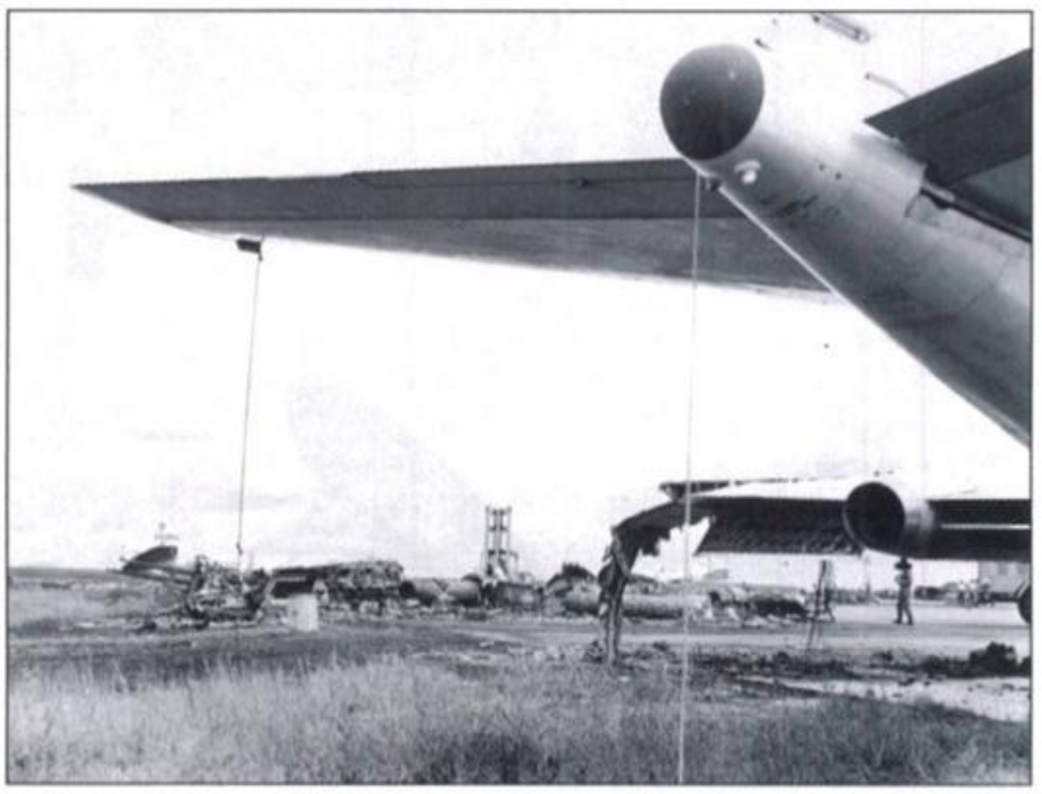
Bombing system
The Canberra was optimised for the LABS delivery of a single special (nuclear) weapon. This technique obviously had no application over the jungles of Vietnam, where dive bombing was the preferred method of bomb delivery. Standard attack avionics included an APW-11 Bombing-Aid Radar Guidance System for the pilot and a SHORAN bombing system for the bombardier.

Revised canopy
The bubble-type canopy of the B-57A was replaced in the B-57B with a 'fighter-style' tandem unit. This added 387 lb (176 kg) to the aircraft's weight but, unlike that of the earlier variant, incorporated an optically flat windscreen through which a gun sight could be properly aimed.

Wright powerplant
Two 7,200-lb st (32.02-kN) Wright J65-W-5 turbojets (license-built Armstrong-Siddeley Sapphires) powered the B-57B. The engines were started independently using starter cartridges, a messy affair which was characterised by some 10 seconds worth of black smoke from each engine. The exhaust port for the engine starter was mounted on the upper right side of each nacelle, crews generally preferring to start the right engine first. This allowed hydraulic pressure for canopy closing to be built up before the port engine was started. Failure to follow this procedure could result in a cockpit full of acrid smoke! Later, a much cleaner, smokeless starter cartridge was introduced.



Above: The devastating, brilliantly executed VC mortar attack against Bien Hoa on the morning of 1 November 1964 made the most of American and South Vietnamese unpreparedness for guerrilla tactics such as this. The Canberra force was struck a severe blow in terms of damaged airframes, but more seriously in terms of morale. Miraculously, the fuel bladders in the right foreground survived intact.



Two B-57Bs were completely destroyed – the only recognisable pieces of debris were two pairs of J65 engines. Just a week earlier, twice the number of B-57s were on the crowded Bien Hoa ramp and the VC might have scored an even greater victory. Many Americans on the base had suggested that such an attack might come, but no action had been taken, perhaps because the South Vietnamese had responsibility for base security.

Combat Sky Spot missions were only rarely undertaken by B-57s and were eventually the preserve of SAC's B-52 force. Sky Spot used ground radar stations to guide bombers to their appointed target, weapons release being on voice or electronic command. This early 1966 photograph of such a raid includes an EB-66B Destroyer employed as a radar jamming aircraft.

Left: More hole than wing? The B-57 could, and did, survive enormous amounts of battle damage and still bring its crews home. 53-3906 was peppered with fire over Tchepone, Laos on 15 March 1966. The aircraft lost cabin pressurisation and use of its electrical and hydraulic systems, but still refused to go down, returning its pilot Larry Mason and his navigator safely to Da Nang.

combat. In the meantime, their presence in Vietnam provided a stronger US fighting force, which may, or may not, have had an effect on enemy strategy.

Although a portion of each of the two bomb squadrons was deployed to South Vietnam, their presence was given little notice in the war effort. Politically, jet aircraft of any type could not be used because it was against the Geneva Accord of 1954, which stipulated that no new military weaponry would be introduced in Vietnam by either side. Seemingly as a pacifying gesture, the Canberra crews were given road reconnaissance missions – but no engagements or attacks were allowed, so the B-57s flew unarmed. They were to cover the roads leading out of Saigon, and report any enemy ground activities or road blocks along these routes. These missions, although flown with much enthusiasm initially, were usually futile. Occasionally a flight would report a road block thrown up by the Viet Cong, but these reports seemingly were not utilised in strike missions. Sortie requirements degenerated to four per day and, to keep everyone busy, one crew would fly for 30-45 minutes then land so that a crew change could be made with engines running, and the same mission would continue.

Mortar attack

By this time the Bien Hoa commitment, more formally called 405th ADVON 1, was an unpopular TDY (temporary duty) as far as the air crews were concerned. This attitude was due, in part, to the extremely limited activity afforded the B-57 aircraft. Other air units using propeller-driven aircraft were launching from Bien Hoa, and were under a full combat commitment, while the Canberras were restricted from actual strike missions. Tensions mounted, exacerbated by teasing from those engaged in the 'real war'. To ease this strain on morale, squadron members were rotated regularly from their home base at Clark so that the TDY period was only one week per month for each crew. Half of the aircraft were returned to Clark on 15 October to reduce the TDY burden and the load on the overcrowded base. In some respect, luck was changing for the B-57s, yet disaster was about to strike.

Hardly three months after the arrival of the B-57s at Bien Hoa, a catastrophe took place. A surprise enemy mortar attack dealt a crippling

8th and 13th BS Canberras rest at Phan Rang between sorties while a C-123 Provider lands in the background. As well as regular 'trash hauling', the C-123 had a closer than usual relationship with the Canberra, the latter providing flak suppression for the former during Ranch Hand defoliation missions.

blow to the base and its occupants. Everyone had talked of the possibility of such an attack, but nothing had been done. Seemingly, the reason was that the bomber squadrons and other American units were merely tenants on the base, with base security provided by ARVN (Army of the Republic of Vietnam) forces.

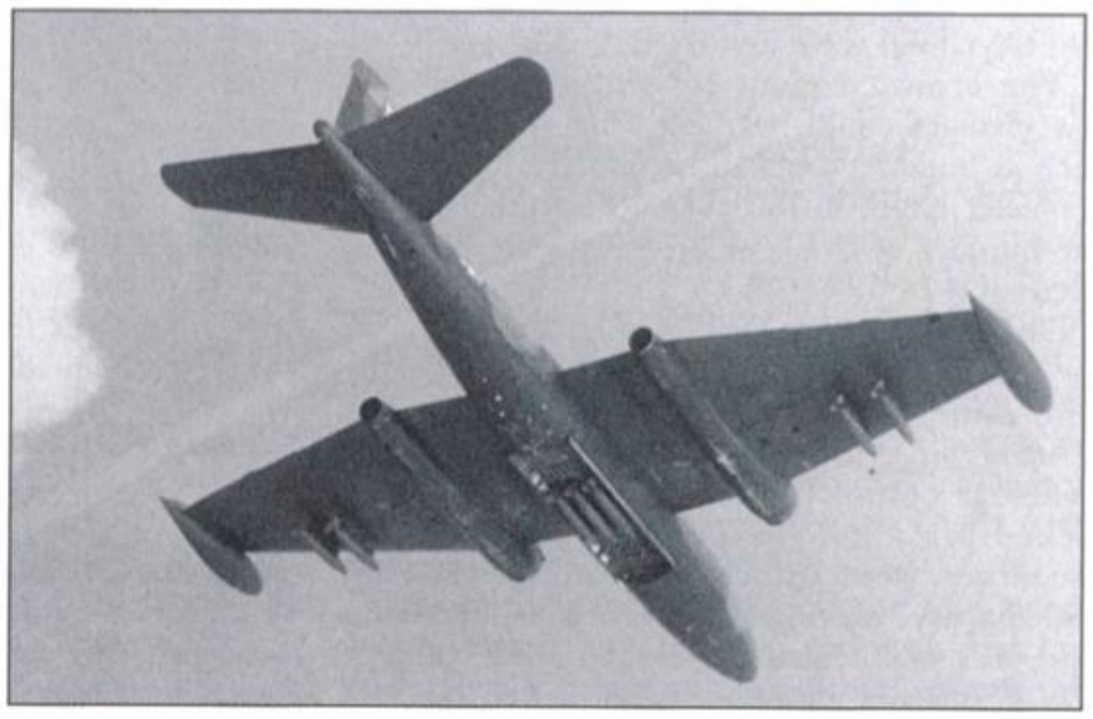
At 00:25 on 1 November 1964, the possibility became reality. The Viet Cong launched a stand-off mortar attack on the base, using six 81-mm mortars emplaced less than one-quarter of a mile (0.4 km) from the northern perimeter. Communist gunners fired 60 to 80 rounds into the base and swiftly departed, undetected and unmolested. At the sound of the first incoming enemy fire, everyone took cover. The explosions that followed, coupled with the illumination caused by flames, made it evident that the rounds had hit home. The Canberra crews were billeted in the American compound in the centre of the main base, and given the direction of the fire there was little doubt that the B-57 ramp had been hit. Of the 20 Canberras parked wingtip to wingtip in four rows, five were destroyed, of which two were burned to the ground. Four Americans were killed and 72 others were wounded. The Viet Cong were the victors that night, inflicting damage out of all proportion to the effort

Into harm's way: 'mud-moving' and CAS

While temporarily at Tan Son Nhut, the Canberra unit flew an average daily rate of eight daytime sorties within South Vietnam and three missions per night over North Vietnam on armed reconnaissance. An example of these air-to-ground missions was one to aid the stricken Special Forces camp in South Vietnam at Dong Xoai. This was in June 1965, when the camp was partially overrun by a regimental-size force of the enemy. The VC – armed with a staggering array of 81-mm mortars, machine-guns, recoilless rifles and flame throwers – had taken advantage of the low clouds and darkness to launch an attack. By morning, when air power could be used, the enemy had overrun the camp's airstrip and occupied half of the camp itself.

In spite of a 900-ft (275-m) scattered-to-broken ceiling obscuring the target, the Canberra crews elected to dive bomb, to ensure accuracy. The initial drops destroyed six Viet Cong anti-aircraft sites. As a result of this B-57 flak suppression, the A-1 Skyraiders attacking the approach routes to the compound were able to halt temporarily the Viet Cong drive. The FAC at one point called for tactical support against 'anything moving outside the compound walls'. This close air support was later credited with breaking the enemy attack and reducing friendly casualties. One B-57 pilot was wounded during the Dong Xoai battle when a 0.50-in bullet entered the bottom of the fuselage and ricocheted several times, finally striking him. In shock and severe pain, and bleeding profusely, he 'babied' his aircraft back to Tan Son Nhut, his navigator talking to him continuously to keep him conscious. Following a successful landing he was pulled unconscious from the cockpit and taken to the hospital.

What happened after that has become a legend in Vietnam annals. This wounded pilot regained consciousness in the emergency room and slipped away unnoticed. He somehow made his way to the flight line and was apprehended in a severe state of shock trying to get into another B-57. All the way back to the hospital he demanded to be released because "I know where they are now and I'm going to get them." (This courageous pilot was shot down in Laos seven months later and not recovered.)
All losses are tragic, some more than others because of the circumstances and kinship felt with the men involved. One such loss occurred on 29 June 1965, following an air strike in support of Vietnamese Rangers in contact with the Viet Cong. While on his last strafing run, 'Bud' (Samuel P.) Chambers' aircraft was hit by ground fire, but there were no serious indications of trouble. En route home, his wingman observed several 6-in (15-cm) holes in the left wing and a few close to the compressor section of the engine. Fuel was streaming from the wing, although Chambers reported that all indications in the cockpit were normal. A straight-in approach was established for Tan Son Nhut. The gear was lowered and everything was still normal, as verified by the wing man, except that fuel continued to come from the left wing. A safe landing seemed assured and the aircraft was cleared to land. As the wing flaps started down, the flow of air was disturbed and the streaming fuel was sucked through holes near the hot engine and exploded, causing the left wing to break off the aircraft. The crew ejected instantly at a low 700-ft (213-m) altitude – just as the aircraft rolled inverted. The navigator struck the ground while still in his seat, and the pilot's 'chute was seen to stream out as he hit the river. His body was recovered two days later. This incident touched so many that a new officer housing building being constructed at Clark AB was named 'Chambers Hall' in his memory.



This dramatic image was captured from a FAC aircraft beneath the B-57. FACs liked the B-57 because the machine's long slender fuselage made it easy to confirm that the Canberra was pointing at the target. This camouflaged B-57B was photographed during a glide-bombing run and was not quite as close to the FAC as it would appear. The bomb doors are already open, revealing a load of three 500-lb Mk 82 bombs to go with the four similar weapons carried on the underwing pylons.

Having released its bombs towards the target marked by white smoke just beneath the Canberra's nose, YELLOW BIRD 31 of the 8th BS pulls up. At this point the aircraft was most at risk from ground fire, since it was close to the ground and trading speed for altitude.

Four 750-lb bombs underwing and nine 500-lb weapons in the bomb bay meant that the enemy would be taking cover for some time. It was customary to drop only one or two bombs on each run into the target. With four Canberras in a typical strike package, the attack could seem never ending on the ground.

expended. This became a devastating loss due to combat, and the Canberra crews had not yet had a chance to drop even one bomb. In addition to the five Canberras lost, 15 others were damaged and four VNAF (Vietnamese Air Force) Douglas A-1 Skyraiders were destroyed or damaged.

The crowded ramp conditions meant that few changes could be made after the incident, such as building sandbag revetments. To create a smaller target in the event of further attacks, the number of B-57s at Bien Hoa was reduced even more.

The next problem was keeping trained crews for the Canberra squadrons. The 'old heads' who came with the aircraft from Japan were nearing the end of their three- to four-year overseas commitment. Many new arrivals lacked prior B-57 experience and the two squadrons were launching 40 to 50 training flights a day, making Clark resemble a training base. The maintenance workload on the aircraft was drastically increased. The situation was alleviated somewhat by new pilots receiving B-57 transition training with the Kansas Air National Guard at Hutchinson, Kansas, prior to leaving the US. It had been a bombardment squadron with B-57B/Cs before changing to a reconnaissance mission.

President Johnson recognised the need for replacement aircraft and had them provided. Eight came from the Kentucky ANG as Project Red Cherry at the beginning of 1965, followed by two RB-57Bs from the Nevada ANG. Nine more Canberras came in May of that year from the Nevada and Kentucky ANGs; others trickled in over the next 12 months, maintaining the two squadrons at acceptable levels.

Change in tactics

In the opening months of 1965, a major change in air tactics was being formulated. Morale of the South Vietnamese troops was at a very low ebb: no appreciable change in the war situation indicated progress in their cause. American air power was present, including jet fighters, but only propeller-driven aircraft were being used for air strikes. Canberras and other jets continued to fly unarmed visual reconnaissance missions. However, in the previous year, the North Vietnamese had violated the agreement that dictated that condition and the South Vietnamese government was now asking the United States to use jet aircraft in air strikes to demonstrate increased strength.

If the restriction against jet aircraft were to change, the B-57 crews were assured that they would be used. That day came on 19 February, setting a new milestone in the Vietnam War. With Viet Cong troops achieving impressive gains, US Army General Westmoreland, Commander, MACV (US Military Assistance Command, Vietnam) – invoking the authority given him three weeks earlier to use jet aircraft under emergency conditions – ordered the B-57s into action. For two days, B-57 crews had been on alert, and when the execution order was issued at 14.00 they were ready. The first flight of four responded with exuberance and was airborne at 14.30. Twenty minutes later the Canberras were over the target, a suspected concentration of Viet Cong guerrilla forces near Bien Gia, about 30 miles (48 km) east of Saigon. A forward air controller (FAC) in an O-1 Bird Dog had received ground fire and had marked the target with smoke rockets. Major Howard F. O'Neal, Commander of the 13th Bomb Squadron, with Major Frank R. Chandler, Squadron Navigator, peeled off for the attack, the two men becoming the first crew to deliver live ordnance against an enemy from a US Air Force jet bomber, in B-57B Canberra 53-3888.

Following closely on the heels of this first attack was another B-57 flight of four, led by Captain Bennett Stone of the 8th Bomb Squadron with Ray Pence as navigator. A total of 18 B-57s attacked that target and all of the Canberras returned to Bien Hoa unharmed. F-100 fighters joined the attack later that day. A party had been previously organised for that night for those Canberra crews at Clark, and the mood skyrocketed when Major Roy White, Commander of the 8th, announced the news of the raid. Morale literally zoomed, and the next day a high-spirited augmentation force of three more crews left for Bien Hoa.

Two days after this first attack, an Army Special Forces team and a Civilian Irregular Defense Group (CIDG) company were caught in a Communist ambush at the Mang Yang pass

Aircraft marked with the yellow squadron codes, sashes and nose caps of the 8th BS, along with red-marked 13th BS Canberras and at least two B-57C trainers with black sash markings and no nose cap colours, are seen on the overcrowded ramp at Bien Hoa. Up to nine B-57Cs were usually maintained at Clark for training purposes, although their combat capability was undiminished and they were used in combat.

Right: With the Canberra squadrons in a state of flux thanks to the changing war situation, aircraft from the disbanding 90th BS were absorbed by the 13th and 8th Bomb Squadrons. The 90th's squadron colour was blue, as seen on B-57B 'Blue Lima's fuselage sash and nose cone.

An early line-up at Bien Hoa demonstrates not only the numbers of aircraft crammed onto the ramp, but also the austerity of the facilities compared to Clark. Two 13th BS aircraft are parked closest to the camera, with two 8th BS aircraft beyond.

Right: With engine start completed, the landing gear pins were pulled and stowed, chocks kicked away and the indication given that the aircraft was ready to taxi. The aircraft were 8th BS B-57Bs operating as part of the 35th TFW at Phan Rang.

on Route 19, east of Pleiku. Supported by F-100 and B-57 strikes, which prevented the enemy from overrunning Allied forces, US helicopters moved in and successfully evacuated 220 men who might otherwise have been lost. Although the military situation in Vietnam remained discouraging, the events of February 1965 marked a turning point in the war. Officials in Washington no longer talked about withdrawing American military advisors but, instead, now recommended deployment of additional US forces to Southeast Asia, foreseeing a swift conclusion to the war. The restrictions against action by the B-57s had been lifted and when March arrived, they were scheduled to fly their first out-of-country mission in a war that seemed to have no territorial boundaries.

To provide maximum support, more aircraft and crews arrived from Clark, bringing the total force to 28 aircraft and 30 crews. Three possible targets were planned and studied, all seemingly in high-risk areas having radar-controlled AA gun protection. The selected target was Xom Bang, a military staging area 17 miles (27 km) north of the DMZ (Demilitarized Zone). Despite a one-day delay due to weather, the attackers became airborne at 14.50 on 2 March, dampened only by a drizzling rain. One aircraft aborted of 20, and it was replaced by one of two airborne spares. The Canberra crews left nothing to chance and were determined to give a good showing. Spaced 10 minutes apart, the bomber formations of five flights of four aircraft each passed their checkpoint at Da Nang. There they turned their radios to the target area control frequency, only to be stunned to hear that three flak-suppression F-105s had already been downed by intense AA fire in the target area. Heavy resistance was expected, and this news confirmed it.

The bombers pressed on and as the former capital city of Hue came in sight, they went 'on the deck' to avoid radar detection until the pop-up for the actual dive bomb run. All crews were to make one pass only, releasing all ordnance, and a second pass could be made only if the first was not successful. At the time of the arrival of the lead flight on target, some areas were already smoking from flak suppression ordnance. The Canberras led by Major Roy White came in and dropped without difficulty. After his flight had made its attack, the B-57s stayed nearby and flew air cover for the other flights until low fuel demanded that they depart and recover at Da Nang.

Some battle damage was incurred, but none serious enough to cause major problems. The Canberra crews felt they had at last earned their place when bomb damage assessment photos showed over 95 per cent destruction in the target area. The heavy loads carried by the B-57s had indeed proved deadly against the North Vietnamese. The 20 aircraft dropped over 96 tons of bombs, with a distance to the target of 450 miles (725 km).

The missions became more challenging as enemy resistance increased, and combat losses soon began. The first occurred on 11 March 1965. Bill Mattis and Dick Smith were on a two-ship in-country strike when their Canberra erupted in flames during an attack and crashed about three-quarters of a mile (0.5 km) beyond the target, killing both men. Jim Lewis, flight leader on that mission, and his navigator Art Baker were the next to be lost, on 7 April. Their Canberra failed to recover from a dive-bombing pass, apparently being hit by ground fire during the attack.

The nocturnal 'caterpillar'

While B-57s proved their worth as excellent close air support aircraft during the day, it soon became evident that the aircraft was best suited for the night interdiction role. Enemy supply lines flourished under cover of darkness, and in March 1965 B-57 night missions from Bien Hoa began, with the intention of slowing this traffic. In anticipation, the two B-57 squadrons had begun night flying training at Clark at the turn of the year.

For the first night missions, the lead aircraft was to locate the target area and drop parachute flares for illumination. The second aircraft then made regular ordnance passes with bombs and guns. Later, experiments involved the use of a

With the introduction of camouflage from 1967, a system of two-letter squadron identification codes was implemented for tactical aircraft. 'PQ' identified the 8th BS when equipped with B-57Bs, although the unit later adopted the 'FS' and later 'FK' codes of the 8th TFW when equipped with B-57Gs at Ubon RTAFB, Thailand.

The battle at Plei Mei

Combat missions, like anything else repeated frequently, can be expected to become routine by following a fairly consistent pattern. When standing alert in support of American forces and ordered into the air, however, anything could happen. And happen it did, when such an alert was sounded asking for close air support to the beleaguered Plei Mei Special Forces Camp situated in II Corp.

This mission began in the early morning hours of darkness on 20 October 1965, when 8th Bomb Squadron crews responded to the launch order. Turning south from Da Nang, Plei Mei was about 20 minutes away. They were the first aircraft to reach the scene, where the enemy was trying to overrun the camp. Their air strikes were hampered by a low 3,000- to 4,000-ft (914- to 1219-m) ceiling. Above the clouds was a C-47 dropping flares over the camp, brightly illuminating the clouds. With the enemy at the camp perimeter wire between the camp wall and the runway, the FAC requested the two B-57 crews to drop their bombs along and parallel to the wire, but NOT to hit the dirt runway or damage the camp barrier wall. This made for a very narrow confining strip for weapon aiming.

Unable to glide bomb in the B-57's usual weapon delivery mode because of the low ceiling, level bombing had to be done in which the pilot toggled off the bombs according to his own calculations, based on experience. Each Canberra carried 21 260-lb fragmentation bombs on its bomb door. After both aircraft had made two passes, dropping all these bombs while under a white silhouetting ceiling which made them easy targets for the enemy, the ground attack had been stopped cold. Fortunately, the enemy had not fully established its 0.50-in AA gun position on a rise south of the camp, allowing the Canberras to strafe the retreating insurgents – who were also well lit from above. The crews were then directed by the FAC to drop the remaining four 500-lb GP bombs that each B-57 had under its wings, on a suspected enemy staging area.

The Plei Mei fight appeared to be over, but this was not the case. Soon after daybreak, TOUT 21 and 22 – two other 8th Bomb Squadron B-57s – left Da Nang on a routinely scheduled in-country strike on a preselected target. This was to be in I Corps' area along the 'Street Without Joy', northwest of Da Nang. Soon after becoming airborne, the Canberra crews routinely changed their radios to the Direct Air Support Center's frequency and checked in with 'Big Control'. This agency had operational strike control over tactical aircraft in the I Corps area, and would pass along any new information pertinent to the strike mission.

Eight M117s fall from a B-57B. The aircraft was pictured during a Combat Sky Spot mission, where bombs were dropped through an underlying cloudbase under radar control. This procedure was not possible in the less than ideal bombing conditions around the base at Plei Mei.

The routine of their planned mission ended at that point, however, for as soon as contact was made with the DASC they, too, were diverted to Plei Mei. A FAC was on the scene, ready to direct attacks. Things had happened since the first B-57s had left, and smoke from a downed helicopter and U-6 Beaver readily identified the spot for the two B-57 pilots. The Viet Cong forces were now estimated to be of regimental strength, since they reappeared after the first B-57 strikes. They did not retreat under the helicopter air attack, and had already inflicted heavy casualties on the camp. Heavy ground fire was observed by both Canberra crews and was also reported by the FAC. It was later learned that this was the first major battle with North Vietnamese regulars who would now stand and fight.

Cloud cover in the area remained at 4,000 ft (1219 m) so the Canberra crews also had to improvise with level bombing runs at 2,200 ft (670 m) and 350 kt (400 mph; 645 km/h). They released one wing bomb at a time on known enemy troop emplacements. After four or five passes by each aircraft, they initiated strafing runs covering strategic areas of concealment where the enemy was likely to have vantage points.

On the lead aircraft's third strafing pass, the Canberra took numerous hits from the south ridge, which now had 0.50-in machine-guns in place. A bright orange ball of fire appeared briefly over the right wing and the tip tank, and part of the right wing left the aircraft. The B-57 seemed to be still under control – for the time being, at least. The second B-57, having seen where the ground fire came from, directed its next strafing pass on that position. As it pulled up from the run, the aircraft took a hit, a resounding explosion occurring in the cockpit between the two crew members' seats. The cockpit immediately filled with smoke. The hit rendered the oxygen system useless, making breathing under these conditions almost impossible. When the cockpit was cleared and the crew could see and breathe freely, it became apparent that electrical navigation equipment was also inoperative.

By now, the lead aircraft's problems were beginning to multiply. With a jaggedly split right wing tank and a hung bomb on the left wing station, the aircraft became uncontrollable when the airspeed was allowed to decrease. Nothing would jettison, not even the full internal load of 260-lb fragmentation bombs. There was no other recourse than to bail out while the aircraft was still under control. Setting the aircraft in a climb as they headed toward Pleiku, where rescue helicopters had already been summoned, both crewmen punched out just before the aircraft lost control. Despite the damage to the second B-57, that crew circled the area of their downed team-mates while directing the rescue operation and providing air cover until they were safely aboard the rescue helicopters.

The crew in the second Canberra limped their aircraft to the nearest air base, Pleiku, and landed safely, having to use the emergency hand pump system to lower the landing gear. After a successful landing, there was a welcome reunion for the four at Pleiku, although one crew member – the only one injured – had fractured a vertebra and was hospitalised at Pleiku, and later air evacuated to the US.

As for the besieged outpost of Plei Mei, six more B-57s entered the attack that morning, followed by other strike forces. After two days of intense fighting and helicopter airlift of support elements, the camp was finally secured.

Many acts of heroism among crew members of the B-57s were created by combat situations. Not only do the favourable outcomes of these situations reflect well upon the crew's knowledge of their aircraft and related systems, they also show that the B-57 could withstand the punishment inflicted by combat damage.

C-130 as the flare ship, which freed both B-57s to work the target. By the time the B-57 crews were trained and ready for night intruder work along the supply routes in Laos, a well co-ordinated system had been established.

Given the aircraft's ordnance loads, it was the rule rather than the exception that one or more trucks would be hit and explode or burn, even though concealed from sight. Sometimes this would cause a chain reaction with nearby trucks, and the kill for the night could become quite high. Even if targets were missed, the mountain roads would be damaged and would require extensive repair, which considerably limited truck traffic – this being the objective.

Most of these strikes would be interrupted by automatic weapons fire from emplacements strategically located along the supply routes. The same flares lighting the ground also silhouetted the B-57s at certain points during the attack. As Canberra crews will attest, the defensive fire could be effective. Many a tail feather came home riddled, and some did not come back at all.

The first night missions into Laos took place on 1 April 1965 in the area of Tchepone, where the supply routes filtered in from North Vietnam. As flares from the accompanying

A flightline explosion proved even more devastating than the earlier mortar attack on Bien Hoa. Captain Charlie Fox and his navigator Vern Hayes were awaiting engine start as the lead aircraft of JADE FLIGHT on 16 May 1965 when their B-57B exploded. Two other JADE FLIGHT aircraft were parked nearby, their crews strapped in with no chance of escape; all six men died. The fourth aircraft of the flight was parked some distance away, its crew abandoning ship and sprinting for cover. Another pilot, forced to abort his mission as part of the previous flight of four Canberras to leave the airfield, was killed as he walked from his broken B-57. His navigator was badly injured.

Above: With some hard-learnt lessons behind them, the US forces ensured that anti-blast revetments became standard equipment at in-country bases. This camouflaged B-57B is unusual in retaining pre-war gloss black tip tanks.

Right: It took 10 minutes to top up the B-57's liquid oxygen system and the task was normally one of the last completed before flight. It was a dangerous job, thanks to the extremely cold temperature and volatile nature of the gas.

C-130 began illuminating the area of a suspected river crossing, a ferry boat was spotted and the attack began. When the strike ended, the estimate of damage was one ferry boat destroyed, four trucks sunk with it, one bridge and approaches damaged and approximately 20 buildings destroyed by secondary explosions. Pressing the mission even further, the night interdiction team continued north to the Mu Gia Pass on the North Vietnam border. This first night mission into Laos marked the beginning of Operation Steel Tiger, a limited day and night US air campaign against enemy troop and supply movements within the panhandle of southern Laos. It ran in conjunction with a strictly daytime operation called Barrel Roll, which had begun on 3 March aimed against Communist Pathet Lao and North Vietnamese troop movements. By December 1965, Tiger Hound had become another familiar term and was well remembered by B-57 crews for strikes along the vast network of the Ho Chi Minh Trail, all identifying areas of interdiction missions of enemy supply routes.

Night interdiction 'up north'

Eventually these night interdiction missions were extended into North Vietnam, the first taking place on 21 April 1965. At this time, the C-130 flare ships had not been approved for North Vietnam missions, so each of the two B-57s carried Mk 24 flares as well as six 500-lb bombs and eight Mighty Mouse rocket pods containing seven 2.75-in rockets each. Attacks were made against a railroad bridge and a concrete span bridge near Vinh, 160 miles (257 km) south of Hanoi. While attacking the latter, heavy AA fire erupted, and since the bombers had expended their ordnance, the crews were more than ready to vacate the area and head for Da Nang and a fuel stop. In the weeks that followed, only six missions of this type were flown over North Vietnam from Bien Hoa.

Night missions were considered hazardous for various reasons. Vertigo was a primary one, caused by the pilot's loss of a visual reference with the horizon. Other factors included high terrain, inaccurate maps and reduced visibility due to the bright flares that destroyed the crews' night vision. Many times the crews flying these missions had to fly two or three nights consecutively; coupled with having to sleep in 90°F (32°C) heat during the day, this produced a very special hazard. The dedication and skill of the crews involved meant that no losses were experienced during these initial night operations.

To B-57 crews flying in Vietnam during this early time, the name Bien Hoa has an unpleasant overtone never to be forgotten because of devastating ground disasters. The second of these tragedies occurred on the morning of Sunday 16 May 1965, when the lead B-57 out of a flight of four was about to start its engines for an out-of-country strike. Without warning, the Canberra – fully loaded with four 750-lb GPs under the wings and nine 500-lb GPs in the bomb bay – exploded in a ball of flame, generating a concussion wave that threw debris into surrounding aircraft with shattering force. The flying bomb fragments and cannon shells caused a chain of explosions that enveloped the ramp in less than one minute. The explosions hurled fragments as large as soft drink bottles into the cantonment area almost 1 mile (1.6 km) from the ramp. An entire J65 jet engine was thrown half a mile (0.8 km). Ten B-57s, 11 VNAF A-1Hs and one Navy F-8 Crusader, which had landed only minutes before the explosion, were destroyed. Besides the seven crew members killed, 13 members of the 405th ADVON 1 maintenance squadron perished, along with eight Vietnamese, bringing the total number of dead to 28, with 105 wounded. The base was a disaster, and four B-57s returning from a raid were diverted to Tan Son Nhut as were three that had taxied prior to the blast and had escaped damage. Casualties could have been even higher for ground crews had it not been for the arrival shortly before the blast of an unfamiliar Navy aircraft, the F-8 Crusader, which drew curious Air Force crews away from the bombers.

Pausing only briefly to lick their wounds, the men of the Canberra squadrons set up shop at Tan Son Nhut Air Base with the seven aircraft diverted there after the Bien Hoa explosion. Ground crews from Bien Hoa were moved to Tan Son Nhut by bus later that day, and in four days the bombers were again attacking the enemy. Their use was only on a limited basis, primarily to show the Viet Cong that the 'hated' Canberra squadrons had lost none of their punch.

Realistically, though, the force had been badly hurt. The loss of aircraft, crews, maintenance personnel and equipment all contributed to a reduced capability which plagued ADVON 1 for several days.

Tan Son Nhut

The unit's past record was hardly anything to be ashamed of. The wartime rate for the 18 B-57s maintained in Vietnam was 378 sorties, yet they actually flew 552, which was 41 per cent above the wartime rate. Each B-57 was expected to fly an average of 84 hours per month as a wartime figure, giving ADVON 1 a total of 1,512 hours to fly its assigned aircraft. Instead, they flew 2,200 hrs, including two courier aircraft – 46 per cent above the wartime rate. The men of the 8th and 13th were tigers,

This aircraft has a fearsome load of four 750-lb napalm tanks. These containers were never carried internally, while their content was found to be particularly effective against softer targets, such as personnel, trucks and villages.

and nobody knew it better than the enemy.

Operating from Tan Son Nhut (TSN) as a combat base was not easy for a number of reasons. This was Saigon's international airport, handling vast amounts of commercial traffic, and it was also a major military base with many types of combat aircraft. Faced with this congestion, Canberras returning from a strike had difficulty entering the heavy flow of air traffic, and delays on the heavily travelled taxiways cost precious time. Ground crews needed access to the B-57s as quickly as possible, for they had to reservice and rearm some of them for a second and often a third mission in the same day.

The airport was so saturated with aircraft that the B-57s had to be parked on PSP (pierced steel planking) pads. Due to the possibility of ingesting dirt or other foreign objects into the air intake, it was necessary to tow the aircraft to a taxiway for engine start. This not only made operations slower, but it blocked other traffic as well.

Two tents were pitched by a taxiway to house both operations and maintenance, and the dirt and humid heat made working conditions almost unbearable.

Although war is a deadly serious business, humour is important at times when men – witnessing the fall of their comrades, but never growing accustomed to it – must continue their assigned missions. Such a saving sense of humour flashed briefly when a high-ranking officer approached the B-57 crews with a question a few days after the unit moved into its reduced operations at TSN. "Do you really mean," he asked, "that you are running a combat operation out of these tents, on a shoe-string, like a bunch of gypsies?"

"Yes sir," he was told, "but to tell you the truth, we need the work." Morale was on the upswing.

Improvements to the situation were few, but, as with most difficulties, the crews learned to live with it. The arrangement was to be temporary, as it was planned to move the B-57 operation back to Bien Hoa as soon as base repairs were made.

In the meantime, two B-57 Air National Guard units at Reno, Nevada, and Louisville, Kentucky, had been very busy preparing seven and two Canberras, respectively, for ferry flights across the Pacific as replacement aircraft. Just four days after the Bien Hoa explosion, these aircraft were en route to Clark Air Base in the Philippines. It was at this time that a critical shortage of bomber-type B-57s was beginning to be felt within the Air Force inventory. Several measures were considered but none was practical. Aircrews clearly could be retrained to fly another type of aircraft for the B-57's mission, but it became evident that the efficient B-57 itself had no replacement.

Another move – to Da Nang

Instead of moving back to Bien Hoa after the six weeks' stay at Tan Son Nhut, as expected, the B-57 operation was moved in late June 1965 to Da Nang Air Base, a location much closer to the DMZ. This was a growing base, the largest in the northern portion of South Vietnam. This new location provided greater working room for the Canberras and better living conditions for their crews. For the 8th and the 13th, it was the beginning of a combat operation that ran much more smoothly. At Da Nang, they came under the operational control of the 6252nd Tactical Fighter Wing, which became the 35th TFW about a year later.

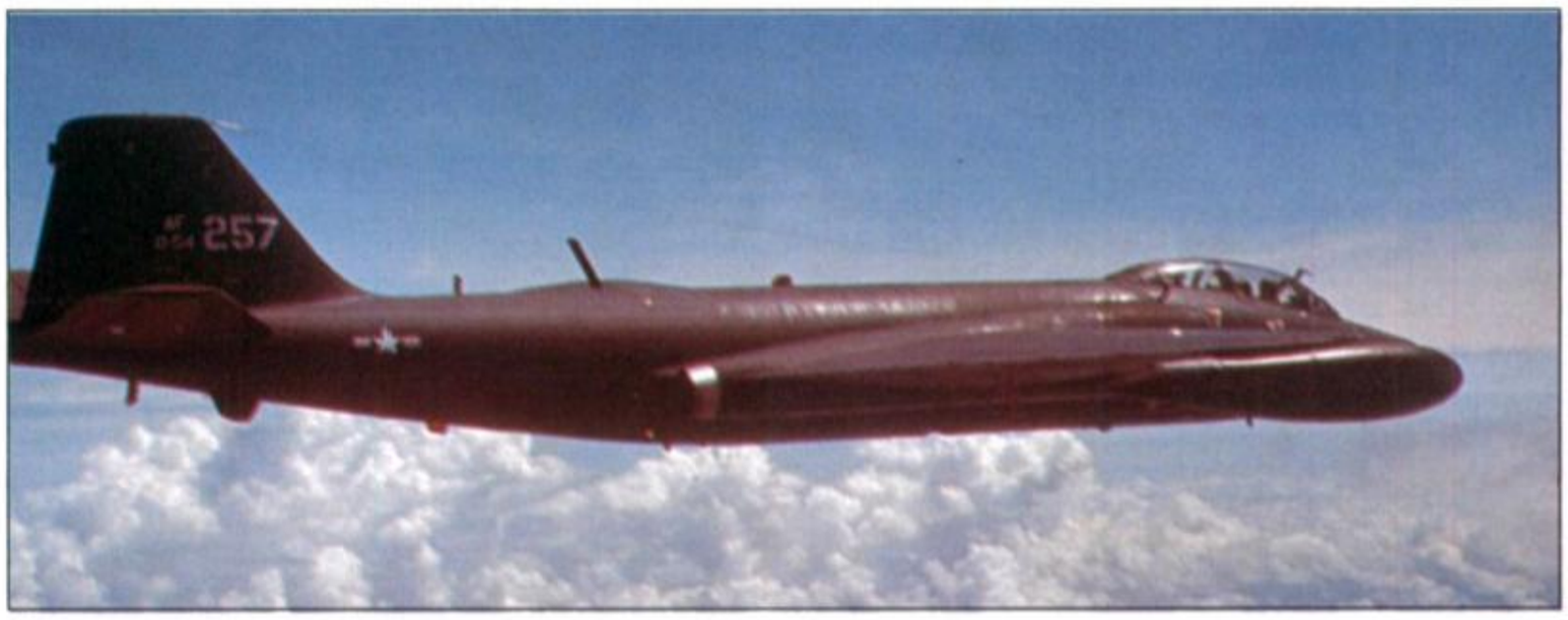
The most noticeable change in the operation was the placing of one entire squadron of B-57s with all their support at Da Nang on TDY (temporary duty), away from Clark, for 60 days at a time, while the other squadron remained at Clark and underwent training for its return to Da Nang. This provided a more equitable arrangement for the crews and ensured continuity in the combat zone, without having to contend with daily crew rotations.

The B-57s were so well known on the tactical scene that, after a few months, nondescript callsigns such as SOFA, KAY, NEWT, DARK, etc. had given way to the more affectionate YELLOW BIRD or RED BIRD for the 8th and 13th, respectively, depending on the squadron colour of the unit then in-country.

Missions of varying types for the B-57s made the war anything but boring, one being flak-suppression with the C-123 Ranch Hand defoliation aircraft.

The presence of the Canberra in company with the Ranch Hand aircraft acted as a

Above: Among the B-57 community in SEA, the Patricia Lynn aircraft were very much first in and last out. This machine was photographed at Tan Son Nhut on 29 November 1965, with an all-black B-57B parked to its left and a VNAF B-57B in the revetment at its rear. The RB-57Es tested all manner of onboard and podded reconnaissance systems.



Having originally reached the combat zone in 'natural metal', the RB-57Es eventually adopted this overall Flat Black scheme. This was much to the dismay of their crew's however, who considered that the unusual scheme marked them out as 'special' and that they would therefore attract more AAA fire. This aircraft was photographed in late 1968/early 1969 and was on the strength of Det 1, 460th TRW.

VNAF Canberras

Initially reluctant to give the Vietnamese Air Force (VNAF) an autonomous bombing capability with the B-57, the US was eventually persuaded to provide a token force of aircraft in the light of assistance given to other nations. In May 1964, VNAF Maj. N. N. Bien and Captains Tuong and Long arrived at Clark AB for their training. All three men were veterans of extensive combat and all three proved to be superb pilots. The next three pilots were to be trained at Tan Son Nhut, since they were very senior officers within the VNAF, namely, Nguyen Cao Ky – Commander General of the VNAF and later Premier of the Republic of Vietnam, Col Luan – charge of internal security for Ky and Maj. Van – Chief of the VNAF Command Post. Strangely however, it was not until 9 August 1965 that the VNAF's new-found capability was officially announced and presented to the Vietnamese government. That day, assembled dignitaries at Tan Son Nhut were treated to a low-level, three-ship fly-by of VNAF-marked B-57Cs. The aircraft broke and landed in spectacular fashion, before taxiing out of sight for their American pilots to leave the cockpits. Thus the VNAF pilots, including Premier Ky, were seen by the people in the visitors grandstand to be the solo pilots of the three jets. A transition and weapons delivery school was soon started at Clark for VNAF pilots, with navigators soon joining the programme too. In the closing months of 1965, VNAF crews began flying combat missions under US control. Meanwhile, problems were emerging at Clark. A second batch of pilots was complaining of various illnesses, which severely curtailed their training, while two accidents further sapped Vietnamese morale. The final blow came on 23 February 1966, when Maj. Bien was killed in a freak accident. Having flown a combat mission from Da Nang and with a low fuel state and hung ordnance, Bien elected to recover at Pleiku. The B-57's engines were shut down and the aircraft dearmed. Unfortunately, the inexperienced groundcrew at the base inserted the engine starter cartridges incorrectly and were unable to restart the J65s for the Canberra's departure. They therefore elected to push the aircraft to a new position, with Bien controlling the machine using the wheel brakes. With the engines not running however, hydraulic pressure had not been built up and as the aircraft gathered momentum down a shallow slope, Bien was unable to stop it. He therefore elected to leave the aircraft by jumping out of the cockpit, but stumbled on landing and fell in front of the left main undercarriage. His injuries were fatal and The loss of such a universally respected leader and pilot ended the VNAF B-57 programme on 20 April 1966.

VNAF B-57s passed through the same maintenance cycles as the USAF machines. It was not uncommon for the VNAF to 'acquire' a B-57 through the simple expedient of replacing its USAF marking with the VNAF insignia. In this way, the VNAF fleet of serviceable B-57s was kept at a constant strength.

Over just eight months between 1965-66, VNAF-marked Canberras became a relatively familiar sight at Tan Son Nhut. The aircraft were flown by both US and Vietnamese crews, many of the latter finding the B-57 an overly heavy aircraft in which to fly and fight effectively. Predictably, the VNAF Canberra programme soon foundered, the VNAF crews preferring smaller lighter aircraft, and in fact going on to have considerable success with the supersonic F-5.

deterrent, causing the enemy to think twice before opening fire. When ground fire was encountered, a crew member in the C-123 would toss out a smoke grenade marking the spot and the B-57s would unmercifully saturate that area of the jungle with their guns and 260-lb fragmentation bombs.

The enemy's special hatred for the B-57s was often evident in the testimony of VC defectors. When the VC were interrogated by American-South Vietnamese intelligence about why they defected, many replied that the primary reason was overwhelming American and Vietnamese air power. They exclaimed that there was no place to hide, and they were always kept on the move. Their tactics were continually being modified because of this, and the pounding from the air was unbearable. When interrogators showed defectors the silhouettes of aircraft, most of them immediately pointed to the B-57 as the most despised. "The screaming bird," they would say. "It is the worst. It stays over the target so long. And it never runs out of bombs."

Weapons so dreaded are a psychological asset – for example, the German Stuka dive-bomber of World War II, with its deadly accuracy and awesome scream. The J65 engine of the B-57 also had a peculiar whine all its own. The VC had a contemptible word for the Canberra – 'can sau', which meant 'caterpillar', the little creature that they considered the most loathsome thing in all Vietnam.

The hazards of the 'Doom Pussy'

As time went on these night interdiction missions became the most hazardous because the abundant radar-controlled anti-aircraft guns operated more freely under the cover of darkness. The B-57s were so effective against enemy supply routes at night that it seemed to justify the risk. Only the more experienced crews flew them. It was not long before these night sorties 'up north' were even given a special and ominous-sounding name – 'Doom Pussy Missions'.

This legendary cat got its name from the Da Nang Officers Open Mess, thus, DOOM. On the back of the bar was a tall, slender, carved wooden cat, placed there for no apparent reason even before the B-57s arrived at Da Nang. When fellow crewmen were up north on night missions, evading Russian-made surface-to-air missiles (SAMs) and radar-aimed guns, the cat was turned to face the wall until the safe return of that night's Doom Pussy Missions.

The two B-57 squadrons, alternating their 60-day stays at Da Nang, were attached there for operational control to the 35th Tactical Fighter Wing, an F-100 unit. As higher-performance fighters took over the air war to

With the B-57G came the ability to achieve much lower CEP figures, though this capability came at a price. For an investment of $43 million – a considerable sum at the time – just 16 B-57Bs were converted to B-57G standard. All of the in-theatre aircraft flew with the 8th TFW out of Ubon.

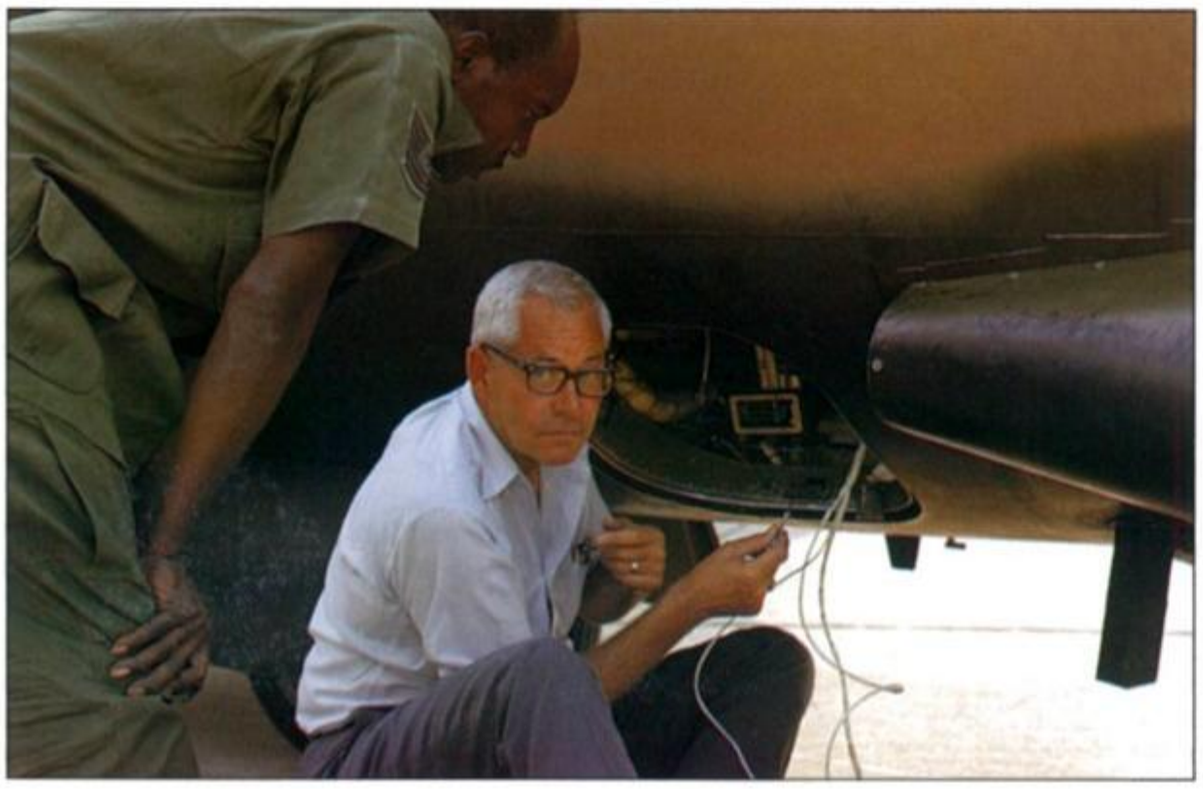
Canberra variants in Southeast Asia

Left: Major modifications to the British Canberra design (B-57A) were introduced in the **B-57B**. Most noticeable was the tandem cockpit, which incorporated a flat panel windshield through which a sight, needed for the air-to-ground role for bombing, gunnery and rocketry, could be used. A rotating bomb-bay door, as introduced on the XB-51, was also fitted. With bombs attached directly to it, the door could open in four seconds and close in six, making a 180° rotation. Buffeting and pitch changes, generally associated with conventional bomb bays, were kept to a minimum.

Right: This model provided a dual control capability for training purposes, yet did not lessen the aircraft's combat capability. Some 38 **B-57C**s were manufactured as part of the total of 403 B-57 Canberras of all models. Of these, nine served with the two B-57 squadrons in SEA, two of which were lost in training accidents and one in combat. The demand for training was so critical when acquiring replacement crews that the B-57Cs available to the 8th and 13th Bomb Squadrons generally remained at Clark AB for this exclusive duty. It was hardly noticeable, but the rear seat in all models, including the dual control B-57C, was slightly offset to the left. Forward visibility for landing was fairly good from the rear seat.

Left: To provide night intruder-configured aircraft, modifications were made to 16 existing B-57Bs withdrawn from Phan Rang beginning in June 1969. Martin modified the nose sections and Westinghouse installed newly-developed sensing and tracking systems to create the **B-57G**. These aircraft carried three sensors: forward looking radar, infra-red and low light level television plus a laser-ranging device. The systems operator worked the equipment from the rear seat while the information flowed through a computer for automatic bomb drop after receiving consent from a switch located in the front pilot's compartment. The pilot received direction from the Flight Director System for target alignment. Bombing runs were flown at 4,000 to 6,000 ft (1219 to 1829 m) above the ground. Once a target was identified, one of four 500-lb laser-guided Paveway Is carried on the wing stations would be released. Four M35 or M36 'Funny Bombs' were carried in the bomb bay for use with the sensored bombing systems. When these were exhausted from stocks, M117 750 lb bombs became the standard internal ordnance. The wing guns were removed, the B-57G being a level bomber.

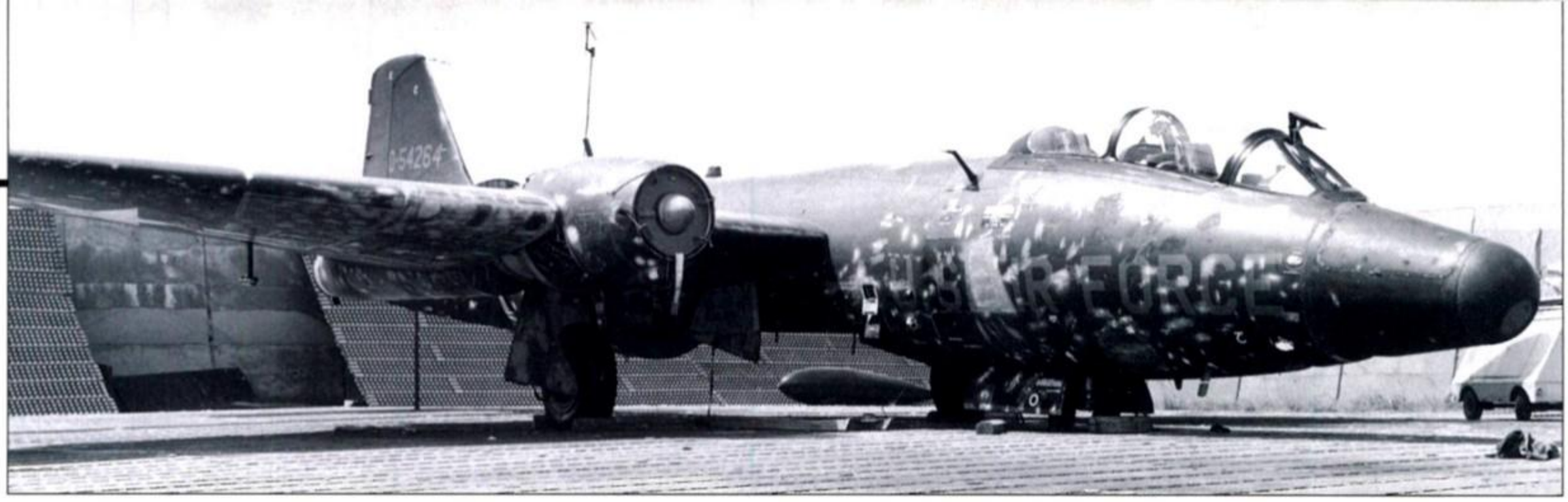
Left: The need for a more sophisticated means of gathering aerial intelligence became increasingly critical as the US military became more involved in Southeast Asia. General Dynamics' plant at Fort Worth was awarded the contract to modify two former B-57E target tugs to carry this new equipment. Initial modifications included the redesign of the forward nose section to house a KA-1, 36-in forward oblique, and a low panoramic KA-56 camera. Mounted on the inside of the specially configured bomb bay door was a KA-1 vertical camera, KA-77 split vertical day-night camera, and infra-red scanner, and a KA-1 left oblique camera. There were frequent changes and updating of this equipment, often requiring the aircraft to return to the US for modification. The last modifications made in the late 1960s put 12-in focal length KA-82, and 24-in focal length KA-83 cameras into the aircraft – the first tactical use of high-acuity, high-resolution photo systems originally designed for spy satellites. In all, there were six Canberras modified to **RB-57E** for the Patricia Lynn project, of which two were lost in combat.



No one who knew the Canberra knew it like Gene Youngs. They called him 'Mr B-57' and he was a Senior Systems Engineer and Martin's field representative in the Far East and SEA for most of his 16-year association with the aircraft. His job was to work with the squadrons to solve technical problems, such as the glitch which afflicted this aircraft's Heading Reference System. 'Mr B-57' is being assisted on this occasion by Master Sergeant Humphries.

the north, it became more advantageous to place the 366th TFW with F-4 Phantom IIs at Da Nang and relocate the F-100s. The new home for the 35th TFW became the newly established base at Phan Rang, just south of Nha Trang and Cam Ranh Bay, and the B-57's forward operating base location was moved with them. This relocation took effect on 13 October 1966, and Phan Rang became the last base of operation for B-57B/Cs engaged in the Vietnam War.

At first, nearly everyone lived in tents until suitable housing could be completed. Typical quarters were long, one-storey wooden structures in which the upper portion of the sides were left open and screened for air circulation. Eventually, a number of mobile homes, commonly referred to as 'hooches', provided air-conditioned comfort for field grade officers and other B-57 crews who



Patricia Lynn aircraft 55-4264 suffered extensive damage during a mortar and rocket attack on Tan Son Nhut on 14 April 1966. Temporary repairs – hundreds of patches to cover the shrapnel punctures in the aircraft's skin – were required and with the pace of RB-57E operations, the aircraft remained in theatre for two months before flying to Gifu AB, Japan for a more extensive repair job.

Right: 55-4264 leaves Itazuke AB en route to Gifu, after a refuelling stop on 26 June 1966.

often required daytime sleep away from the hot outdoor temperatures. Sounds of the war were always present, as protecting South Vietnamese guns would echo across 'Happy Valley' on the west side of the base, and at night flares would light the high ground known to the defenders as 'Old Smokey'.

There was little change in combat activity for the Canberras during their stay at Phan Rang. Their daily schedule usually called for 14-18 daytime sorties and six to eight night sorties. Hazards remained high and four aircraft were lost in combat during the first 15 months at Phan Rang during which the two squadrons continued their 60-day rotational stays.

Golden anniversaries

1967 was a golden year for the two bomb squadrons, for in May and August, the 8th and the 13th Bomb Squadrons, respectively, passed their 50th birthdays, gaining the distinction of being the oldest continually active units in the United States Air Force. On 15 January 1968, however, the 13th Bomb Squadron, known historically as the 'Grim Reapers', was deactivated, and marked the occasion by flying its 1,000th combat sortie. (The 13th was reactivated later as a B-57G squadron, but the lineage had been broken.) This left the 8th Bomb Squadron as the only surviving tactical bomb squadron in the USAF. A permanent change of station (PCS) was made by the 8th, which cut its ties with the 405th TFW at Clark and became an integral part of the 35th TFW now based at Phan Rang. This deactivation of one squadron did not affect the combat status of the B-57s in Vietnam, since just one squadron strength had been in the combat zone at any one time. It did cause another major shuffling of personnel, however. Members having the longest overseas service in the squadron were returned to the US until a strength reduction to one squadron had been achieved. By June 1969 the number of B-57s was reduced to nine, as 12 had been returned to the US over the previous few months to be converted into B-57Gs.

Combat sorties usually consisted of a two-ship daytime strike and eight to 10 single-ship night sorties. A detachment of four dual-control B-57Cs and instructor pilots and navigators remained at Clark to continue training new crews scheduled to join the squadron at Phan Rang.

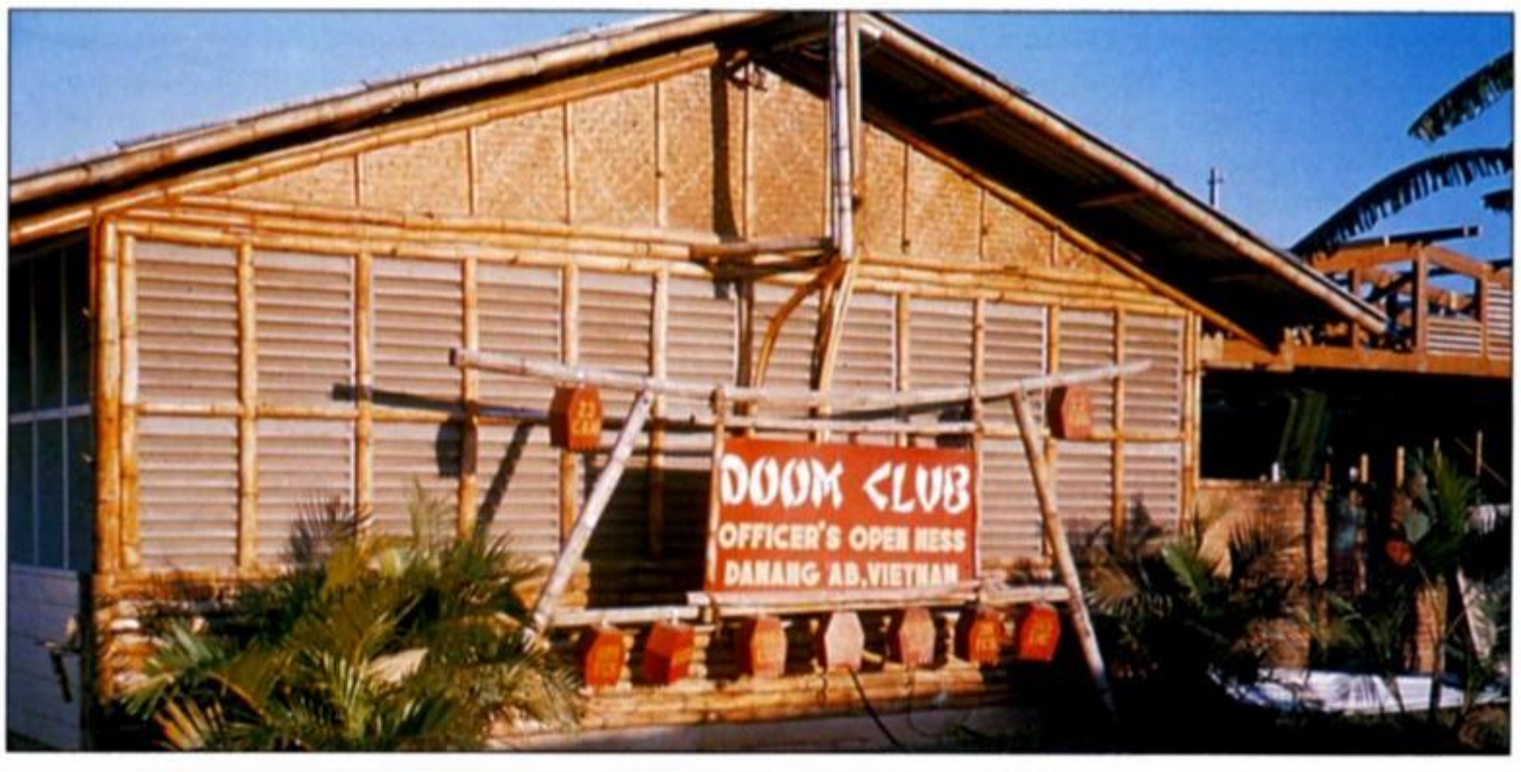
An unusual combat loss took place on the night of 13 December 1968 on what started out as a routine strike over Laos. During the Canberra's ground attacks in the vicinity of Xieng Khovang, the aircraft collided in the dark with CANDLESTICK, a C-123 flare-ship with which it was working, and all the crew members perished except the C-123 co-pilot. The anticipated hazards while operating without lights had been realised.

Before long, the end of operations was in sight for the B-57s that had fought the war for such an extended period. In late September 1969, the Canberras and their crews began leaving Phan Rang and 'Happy Valley' for the last time, returning to Clark to prepare for the long flight to the United States. The last of the B-57Bs to leave Vietnam was 52-1551, having been delayed to have its wing replaced. That last American jet bomber to leave Vietnam departed Phan Rang on 15 October 1969.

While this movement of aircraft was taking place, the designation of the 8th was transferred to a unit at Bien Hoa, to become the 8th Attack Squadron, equipped with Cessna A-37s. The long tradition of the 'Liberty Squadron' continued.

Doom Pussy

Crews who flew missions up north were entitled to wear the Doom Pussy emblem on the right shoulder of their flying suits. This was an embroidered head of a wide-jawed yellow cat with pointed ears and a black patch over its right eye. Clenched in his teeth was the outline of a twin-engined aircraft – very much like that of a Canberra. In green letters around the border were the words 'Trong Mieng Cua Con Meo Cua Tham Phan', which translated from Vietnamese reads, 'I have flown into the jaws of the cat of death'. Returning crews, having had a night of it up north dodging red-hot 37- and 57-mm tracers and Technicolor air bursts that seemed to envelop the aircraft, simply phrased it as "I have seen the Doom Puss."



This fascinating image shows the quality of photograph possible with the RB-57E's onboard sensors. It shows Tan Son Nhut and was taken in May 1968. Among the aircraft types identifiable are a Pan American Boeing 707; several Hercules, both on the runway, taxiing and in revetments at top right; RF-101C Voodoos and RF-4C Phantoms in revetments to the left of the 707's nose; various AC/C-47s; AC-119s; C-123s (some in revetments); Caribous; a C-2 Greyhound, a Boeing 727, at least two UH-34s, a DHC-2 Beaver, an O-1 Bird Dog, at least one C-54, and a C-118, two Boeing 307 Stratoliners and a handful of C-46 Commandos. Air America PC-6s are just visible near the Stratoliners, while a few Canberras and C-141 StarLifters are also present. The T-39 Sabreliners in the revetments near the RF-4C/RF-101C area undertook film courier flights for the reconnaissance squadrons.

This brief account of B-57 activities at Phan Rang is too short to adequately cover the three long years during which combat strikes were flown from the base. Operations had stabilised, however, and aside from losses, the war was being fought without the upheavals experienced in the earlier years in Vietnam. This period did include the Tet Offensive of February 1968, when 22 Canberras were often supporting 30 sorties a day to counter these pressing attacks. When the offensive was routed, the Canberras and their crews continued hitting the enemy, hurting it badly over the entire period, never letting up until the last day they were scheduled for combat sorties.

Of the 94 B-57s assigned to these two bomb squadrons during the six-year wartime period in Southeast Asia, 51 were combat losses (including 15 destroyed on the ground). Of the original 47 deployed from Japan, only one (53-3879) remained to the end. By this time a total of 16 had been withdrawn early to support the B-57G programme. When 31 October 1969 arrived and the B-57 operation of the 8th Bomb Squadron was ended at Phan Rang, 13 aircraft were on hand.

B-57G – a proper night intruder

Originally conceived as a night intruder, the B-57 Canberra could not do the job any better than the earlier Douglas B-26 used so extensively in the Korean War. The G model of the B-57 was developed to fill this requirement for a completely self-contained night-attack system specifically designed to interrupt the flow of enemy supply traffic over the trails of Laos. Thus, 25 years after it had been acquired as a night intruder aircraft, the B-57 was equipped to fill its mission properly.

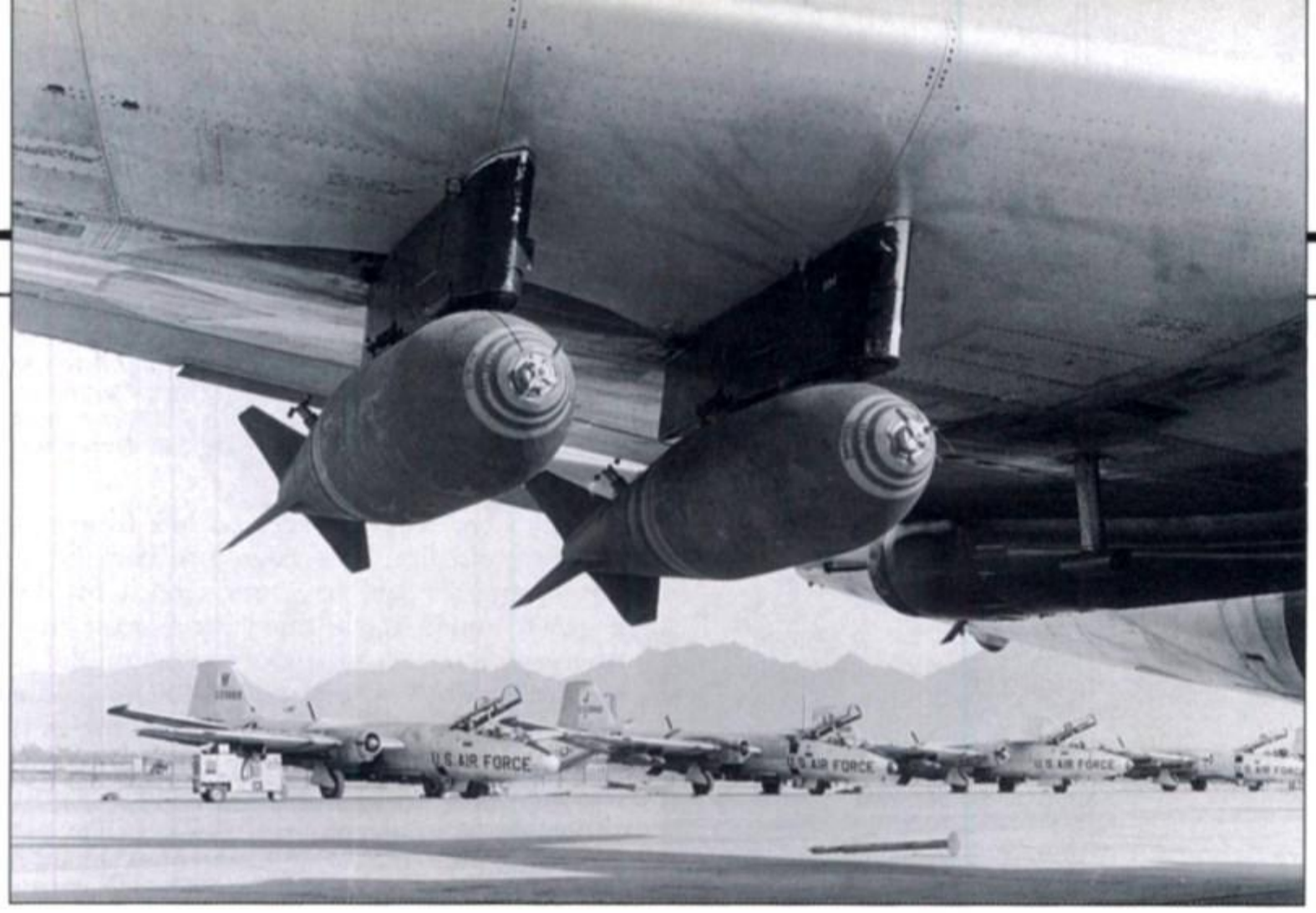
The 13th Bomb Squadron was reactivated at MacDill AFB near Tampa, Florida on 8 February 1970. There, the unit underwent intensive and accelerated training in its highly modified Canberras, the B-57Gs. This would become a truly night-interdiction-capable attack aircraft with its night sensing and bomb guiding equipment. When deemed combat ready, the 13th Bomb Squadron deployed to Ubon, Thailand, in September 1970, and became part of the 8th Tactical Fighter Wing with 11 B-57Gs. Follow-on training for replacement crews was handled by the 4424th Combat Crew Training Squadron, formed at MacDill for this purpose, which retained four Gs and four Cs for transitional training of the new crews.

Lieutenant Colonel Paul Pitt had been with the programme from the early Tropic Moon days that led to the development of the G, and had many good things to say about the aircraft. The G had a new instrument landing system for better all-weather capability. With the docile flying 'feel' caused by the enlarged nose, the aircraft was very stable, which made instrument landing quite easy. It was a bear, however, when landing with one engine and it was wise to hold 10 kt (11 mph; 18 km/h) more than the minimum single engine airspeed of 155 kt (177 mph; 285 km/h) for the standard B-57. Some said that the aircraft was underpowered with the added frontal area, and during the redesign phase the installation of a more powerful engine was considered. Speed was not essential, however, for this mission was normally flown best between 250 and 300 kt (286 and 344 mph; 461 and 553 km/h) indicated air speed.

The only operational loss of a B-57G came on the night of 12 December 1970, deep in southern Laos. The crew, of which squadron commander Paul Pitt was the pilot and squadron sensor operator Lieutenant Colonel Ed Buschette the backseater, safely ejected and were recovered by helicopter the next morning. All believed they had been hit by anti-aircraft fire. When a Cessna O-2A FAC aircraft failed to return from the same operating area, it was concluded that the aircraft had collided in the darkness.

Deadly-accurate B-57G

As American forces were being withdrawn one unit at a time from Southeast Asia, most, if not all, of the B-57Gs were flown to Clark on 12 April 1972. A month later they were ferried to the 190th Tactical Bombardment Group of the Kansas Air National Guard at Topeka. After



Above: BLU-27 750-lb napalm tanks
Below: 500-lb GP bombs fore and aft, 260-lb fragmentation bombs centre

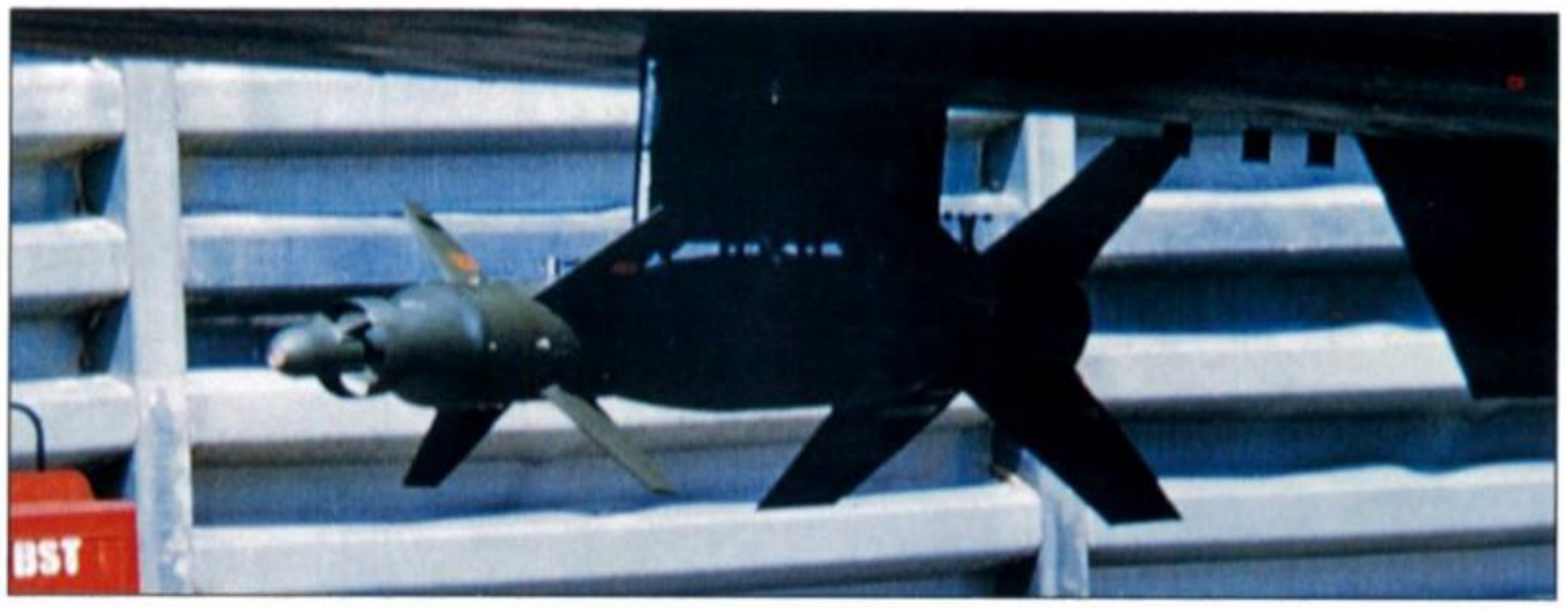
Canberra weapons

Bombs carried by the B-57s throughout the war were fairly consistent in type, but load configuration often varied on the mission and bomb type availability. The wing stations normally carried 4 x 750-lb GP (General Purpose) bombs or 4 x 750-lb napalm tanks. On occasion, 500-lb GPs, 260-lb fragmentation bombs, rocket pods for 2.75-in 'Mighty Mouse' rockets, 5-in rockets, and night flare pods were carried on the wing pylons. Internal loads ranged from 4 x 750-lb GPs, 9-13 x 500-lb GPs, or 16-28 x 260-lb frags. Mk 81 and Mk 82 bombs with either high drag or low drag fins were common. For some special missions, 1,000 lb HE (High Explosive) bombs were carried. On out-of-country missions, M35 and M36 'Funny Bombs' were most memorable to all the crews that carried them. These fire bombs spread a blanket of hot burning thermite over a large area that sustained their fire for up to 10-15 minutes. They were lethal for trucks and area targets. With the advent of the B-57G, the Paveway I laser-guidance kit and new fins were added to a standard Mk 82 warhead, creating the 500-lb Paveway I LGB.

Above: M117 750-lb GP bombs
Below: M36 'Funny Bombs' (left) and M117s

Below left: 750-lb bombs with Tritonal explosive

Below: 500-lb Paveway I laser-guided bomb



two years of service with the ANG, the Gs were retired to the reclamation depot in 1974, and after a time were scrapped.

The modifications of these B-57s as a test programme was an expensive project and proved to be hard to maintain, so the true worth of the effort may seem questionable. The effectiveness of the well-publicised AC-130 with its battery of 'Gatling' guns may well have proved a more economical weapon against truck traffic. Records do show that for the night intruder missions in SEA, 80 per cent of the bombs dropped by B-57Gs using laser-guided bombs hit within 15 ft (4.50 m) of the aiming point. This was constructive evidence that the Air Force had achieved a self-contained, all-weather night interdiction bomber, able to deliver heavier ordnance than guns could provide. Perhaps more importantly, one concept that the test programme was designed to validate was that a 'fast mover' using sophisticated electronic equipment could accurately deliver ordinance at night.

The fact that this concept was proven in combat was instrumental in obtaining support and funding for follow-on weapons systems such as the 'Stealth Fighter', which repeatedly demonstrated to television viewers pin-point accuracy on targets in Iraq and Yugoslavia.

Patricia Lynn

Not all of the B-57 combat missions flown in Southeast Asia were performed by the bomber squadrons. There was a reconnaissance element as well, but it was listed more as a test programme. However, it must be pointed out that these few reconnaissance Canberras provided over 94 per cent of the battlefield intelligence.

Known as Patricia Lynn, this project consisted of so many classified programmes that when the name was mentioned, it was often done hesitantly and in a lowered voice. The aircraft for this USAF project were RB-57Es, stationed at Tan Son Nhut Air Base. Since they were the first aircraft equipped with IR (infra-red) sensors to be used in-country, they were under very tight security control. Not only were these the first jets to be introduced operationally into the air war in Vietnam, in May 1963, but they were among the last of the Canberras to leave Vietnam, in mid-1971. This project, intended to be of very short duration, became the most permanent – lasting over eight continuous years, the longest of any jet aircraft in the Vietnam conflict.

So urgent was the need for reconnaissance information when the aircraft first arrived at Tan Son Nhut that the ferry crews became combat crews and were immediately briefed by 2nd Air Division staff for missions that needed to be flown. The day after their arrival, Captain Bill Scott as pilot, with navigator Lieutenant Bill Sung, flew the first mission, on 7 May 1963. Three days later Don Wachholz and Lieutenant Leo Otway flew the second of two aircraft on in-country reconnaissance. Infra-red photography with good photo interpreters identified such things as VC base camps, small arms factories, storage and training areas that

This 8th BS B-57B was photographed at Clark AB after the unit had withdrawn its Canberras from combat operations in 1969. Of particular interest are the SEA-camouflaged F-102 Delta Dagger and C-130 in the background. The 8th's 'number plate' was later passed on to an A-37 unit at Bien Hoa.

were not otherwise detected by the naked eye. Results of these missions were impressive and the Patricia Lynn project aircraft were kept busy from that point.

By July 1963, the TDY crews had returned to their 6091st Reconnaissance Squadron in Japan and been replaced by permanently assigned crews fresh from the US. The unit became Detachment 1 of the 33rd Tactical Group and continued to grow, receiving two more similarly equipped RB-57Es. These two aircraft were flown from the General Dynamics Plant in Fort Worth, Texas, where they had been modified, to Vietnam in December 1964. The first of these aircraft to wear the black finish arrived in that scheme at Tan Son Nhut on 22 November 1965. This established the maximum number of six aircraft for this unit. More often referred to as just Det 1 throughout its operational period at Tan Son Nhut, the parent unit became the 6250th Combat Support Group on 8 July 1965. A year later it was assigned to the 460th Tactical Reconnaissance Wing, an assignment which lasted until the end of its service.

As early as 1965, Patricia Lynn crews were flying BDA (bomb damage assessment) missions into Laos, teamed with B-57 bombers based at Bien Hoa and a C-130 flare ship, as already described. The first of these night photo missions was for assessing the damage along the Ho Chi Minh Trail, a sortie better known as a Steel Tiger mission. A BDA mission up north with F-100s was flown in mid-March 1965.

Combat situations produce losses, and this unarmed low-flying reconnaissance operation was no exception. The first within a unit is always the most memorable.

While engaged in an in-country night infrared reconnaissance mission on 5 August 1965, a Patricia Lynn aircraft received hits from small arms ground fire. The degree of damage was not known at the time, but circuit breakers began to jump out in rapid succession. Home base was close at hand and the situation did not seem too critical at that point. Aileron control finally gave out, indicating a possible fire in the bomb bay. Unknown to the crew until then, fire was reported by others to be streaming along the left side of the fuselage. The pilot gave the order to eject and both crew members parachuted safely to the ground. The jet crashed 1½ miles (2.40 km) from Tan Son Nhut.

The humour of this accident lies in the fact that the navigator landed in the security zone of a South Vietnamese (ARVN) training camp. Not knowing this, he stayed hidden in the tall grass in which he landed. His 'chute had opened a moment before he hit the ground, and his seat caught on the shroud lines and came down on his head. Fortunately, he still had his helmet in place. Matted grass cushioned an impact that otherwise could have been fatal.

In the darkness, he was suddenly aware that a Vietnamese soldier had walked to within 1 ft (0.30 m) of him and had yet to see him. This friendly ARVN soldier and others were looking for the downed navigator to give help. Expecting this to be an enemy soldier, the American uncoiled his tall and husky body, nearly 6 ft 4 in (1.90 m) and, coming off the ground, he grabbed the Vietnamese around the neck and shoulders with one hand in a near death-grip and with the other pressed his .38 pistol to the side of the soldier's head. The slight man began kicking and thrashing because

Canberra noseart

Nose art was not as common among the B-57 community in SEA as it was with the operators of some other types. This possibly had more to do with the relatively small numbers of aircraft involved, rather than with any lack of artistic ability inherent in their groundcrews. This selection of artwork was all photographed at Phan Rang, the canvases all belonging to the 8th Bomb Squadron. Legend has it that all the artwork was applied using felt-tip pens!

The Pave Gat programme added a six-barrelled 20-mm M61A1 Gatling-type cannon to the B-57G. The gun was gimbal-mounted in the bomb bay and slaved to the aircraft's electro-optical sensors. This gave good accuracy and could have added to the operational capability of the standard Tropic Moon III B-57G but, although tests were performed at Eglin AFB, Florida, the system was not adopted operationally.

Right: Wherever it went, the B-57G caused a stir. The Phantom was also employing the Paveway I system in combat, but designation was achieved via a pylon-mounted pod. An airframe extensively modified with permanently mounted electro-optical and laser-designation systems was therefore something of a novelty in 1972. This aircraft was photographed at Kadena AB during the delivery flight from the US.

his feet couldn't reach the ground. Afraid this giant American would kill him, he kept yelling, "No VC! No VC!" At that moment, the navigator became aware of many others surrounding him as his eyes grew accustomed to the darkness. It was now apparent that he was among friendly South Vietnamese and he hastily withdrew his weapon. This story was often told among flight crews, and it aptly illustrated that a quick trigger finger could suddenly cause a friendly group to become very unfriendly!

The second and last RB-57E was lost on 25 October 1968 after being hit by ground fire in the left engine. Both crew members ejected and were recovered safely. This aircraft was replaced by a sixth Patricia Lynn-configured aircraft, this one equipped with terrain-following radar (TFR).

In 1969-70, there was a renewal in regular Patricia Lynn missions flown in Laos (Steel Tiger and Barrel Roll). There were also special missions into Cambodia to support the US invasion in 1970. Det 1 received a special citation from MACV in 1970, stating that the RB-57Es had acquired more daily targets, both day and night, than the two RF-4C and one RF-101 squadrons of the 460th TRW combined. Statistics showed that with four more RB-57Es similarly equipped, the Patricia Lynn aircraft could have accomplished all the day and night in-country reconnaissance of the Vietnam War. This was attributed to the Canberra's stability, manoeuvrability, versatility of equipment, a longer time over the target area and, not to be overlooked, crew ability. Except for those aboard B-57Gs Compass Eagle IR scanners late in the war, crews relied only on visual map reading to locate, identify and acquire the various types of targets which included night operations. Although these missions were flown at low level, often in darkness, in mountainous terrain and too often in marginal weather, they were done without internal radar or outside navigational assistance. When the Patricia Lynn operation was terminated after mid-1971, one or more of the RB-57Es had nearly reached the 8,000-flying hour mark.

Robert C. Mikesh

Bottom: Bulldozers churn up clouds of dust and a C-123 Provider lands on the opposite runway as an anonymous-looking Canberra taxies at Tan Son Nhut AB. The Patricia Lynn RB-57Es were eventually painted an overall matt black – a feature that some pilots felt attracted the attention of AAA-toting North Vietnamese, rather than making them difficult to spot.

Below: Part and parcel of the Patricia Lynn programme was a great deal of to-and-froing from Vietnam to the US, for frequent modifications and upgrades to the aircraft's systems. 55-4249 was photographed at Elmendorf AFB, Alaska during one such journey.

F.18/37 fighter prototype

Hawker Tornado

Had Rolls-Royce's 24-cylinder Vulture powerplant not found its way into the RAF's Avro Manchester twin-engined bomber, an order for 250 Vulture-powered Hawker Tornadoes placed in 1940 might not have been cancelled. After the Vulture proved particularly troublesome in the Manchester, the Tornado was passed over in favour of additional orders for its sister design, the Napier Sabre-engined Typhoon – an aircraft powered by an engine with which the RAF was to experience problems which themselves took some considerable time to solve.

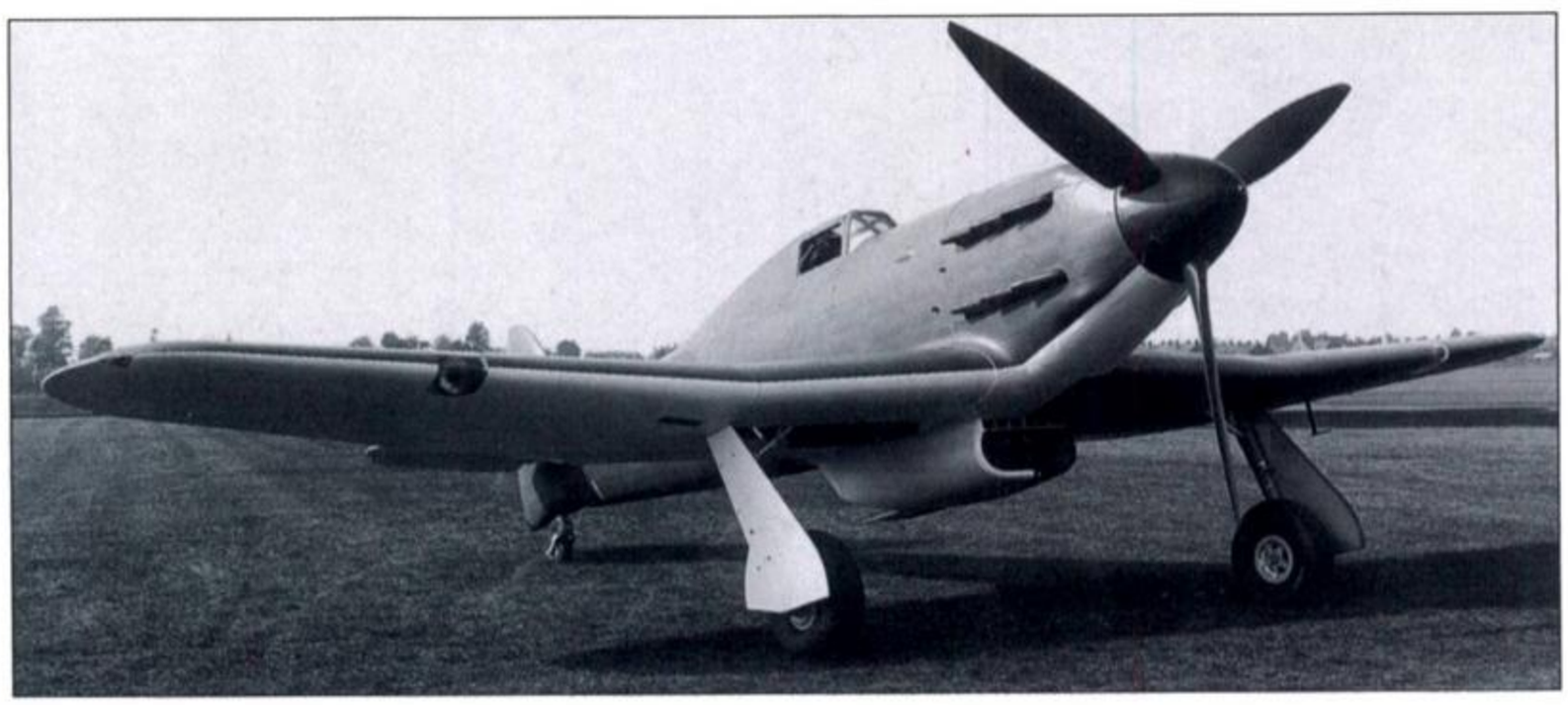
Such was the quickening pace of fighter development that Hawker Aircraft Limited's chief designer, Sydney Camm, was working on a successor to his Hurricane monoplane fighter even before it had entered RAF service. Camm envisaged an aircraft little bigger than the Hurricane but with an engine of twice the power of contemporary Rolls-Royce Merlins, i.e. around 2,000 horsepower (1491 kW). Two new powerplants then in development promised to fit the bill – both rather unorthodox 24-cylinder machines – neither of which had yet flown. D. Napier & Sons' Sabre was of sleeve-valve 'flat H' configuration with four banks of cylinders arranged in pairs, each driving a separate crankshaft. Its Rolls-Royce rival, named Vulture, had an 'X' layout and was effectively two Peregrines (in turn developed from the earlier Kestrel) combined on a single crankshaft.

As insurance against the failure of either powerplant, Hawker submitted two designs to the Air Ministry for its consideration in June 1937 – one powered by the Sabre and known as the 'N-Type' (indicating the Napier engine) and the other by the Vulture and designated the 'R-Type' (for Rolls-Royce). Upon receiving Hawker's proposals, the Ministry advised the company to await the issue of a specification for an advanced fighter, Specification F.18/37 duly appearing in January 1938. This called for an aircraft with the greatest possible speed margin over contemporary bombers and was therefore expected to be able to exceed 400 mph (644 km/h) at 15,000 ft (4572 m). Armament would comprise at least 12 Browning machine-guns of 0.303-in calibre.

Hawker soon received a contract, on 3 March, for four prototypes. Two would be of the 'N-Type' and two of the 'R-Type', construction of the first of each variant beginning later that month at Hawker's Kingston-upon-Thames factory.

Similar airframes

The two designs shared very similar airframes, featuring Hawker's patented tubular construction in their forward and centre fuselages. Steel and Duralumin tubing was used in this box-like structure, which was covered with close-fitting detachable panels for easy maintenance. Extended almost two feet (0.61 m)

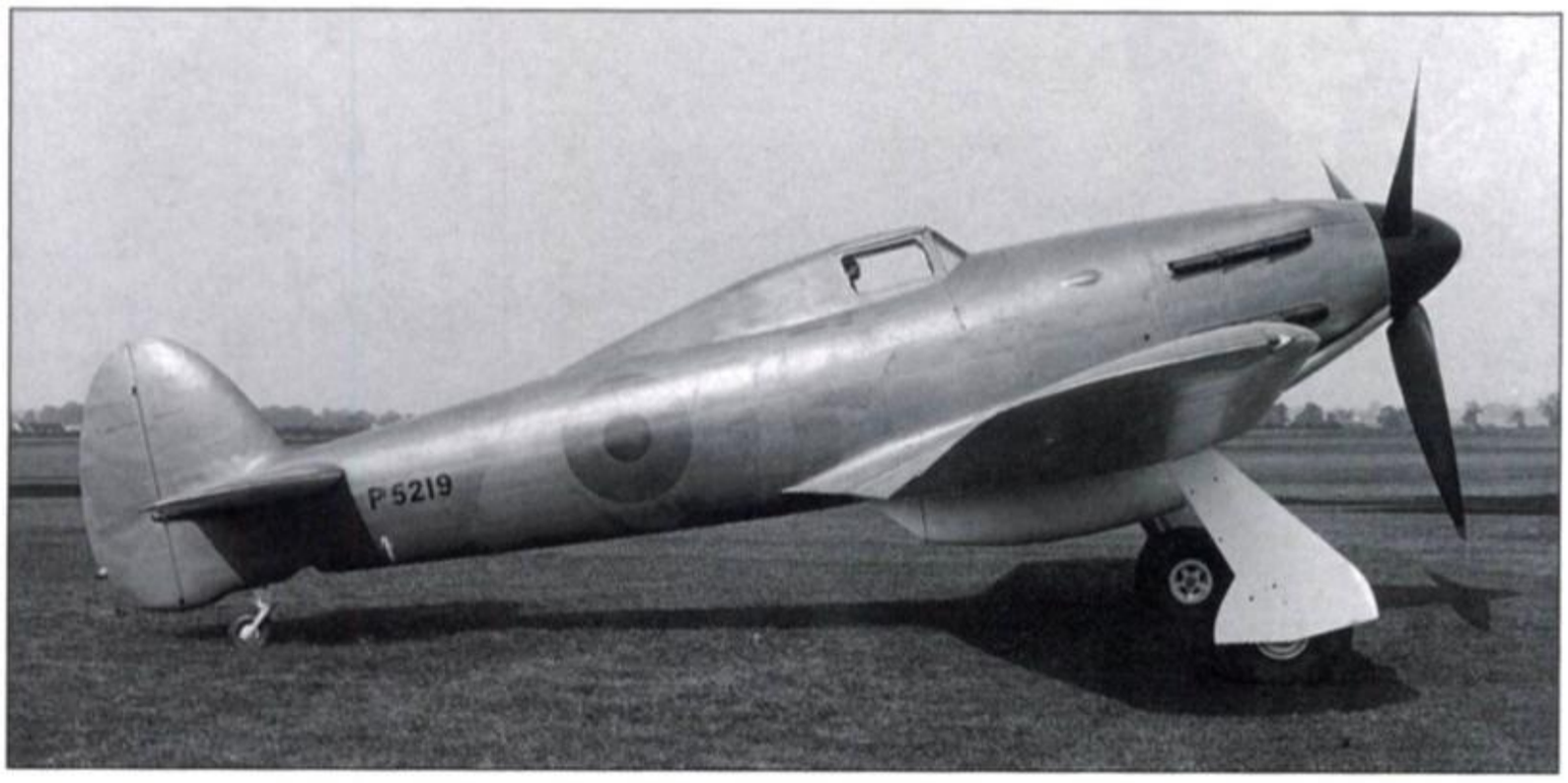


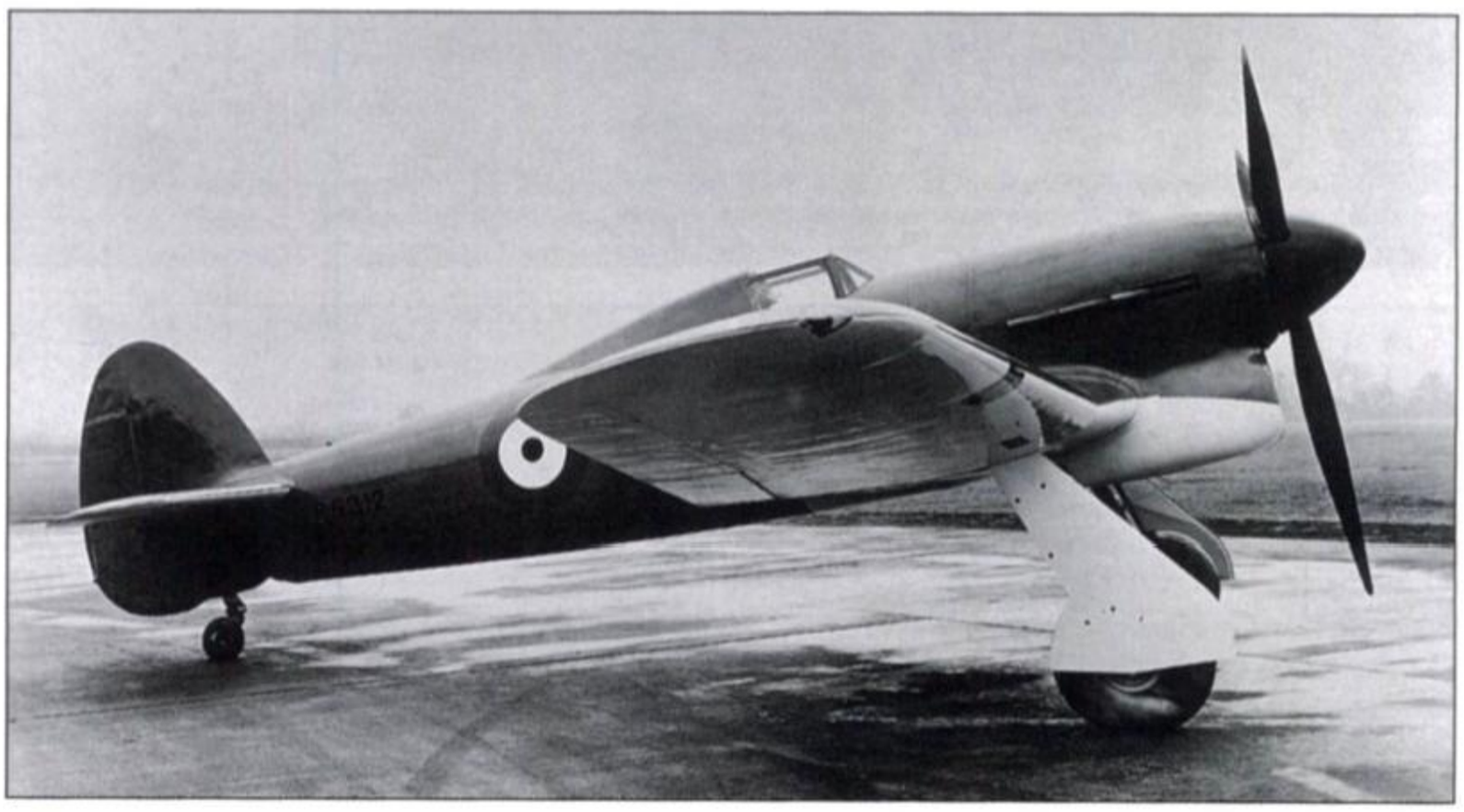
This three-quarter view of P5219 gives an idea of its radiator configuration. Note the undersides of the wings were Night on the port side and White to starboard – standard practice in October 1939 as a recognition aid for friendly AA gunners. Camouflage was Dark Earth and Dark Green.

Left: P5224 cruises at altitude during a flight from Boscombe Down in October 1941. The limited rearward visibility afforded by the cockpit canopy, even with the small Perspex panel provided, may be readily appreciated in this view. Solid canopies were fitted to the first Typhoon Mk IAs to enter service with the original solid rear fairing, but transparent canopies were soon substituted and late-production Typhoons would eventually have sliding teardrop canopies.

Right: An official picture of Tornado prototype P5219, taken shortly after completion in 1939, shows the configuration of the ventral radiator and original smaller tailfin.

Below right: The Tornado's rival – the Typhoon – seen here in prototypical form, employed a 'chin' radiator from the start and, apart from its engine mount, was of identical construction to the Tornado. These comparatively large fighters had a mainplane with a NACA 22-series wing section of 18 per cent thickness:chord ratio which produced buffeting and aileron reversal at high speeds.





aft of the pilot's seat in what was termed an 'integrating structure', this was mated, via four pick-up points, to a monocoque rear fuselage with a light alloy skin. The airframe was thus all-metal, with the exception of the rudder, which was fabric-covered. The cranked mainplanes (the inner section of which had 1° anhedral and the outer section 5° 30' dihedral) was built in two halves, each of which was attached to the fuselage by four bolts, two for each of the main spars. Provision was made for the 12 machine-guns demanded by the specification, each with 500 rounds of ammunition.

Radiator design differences

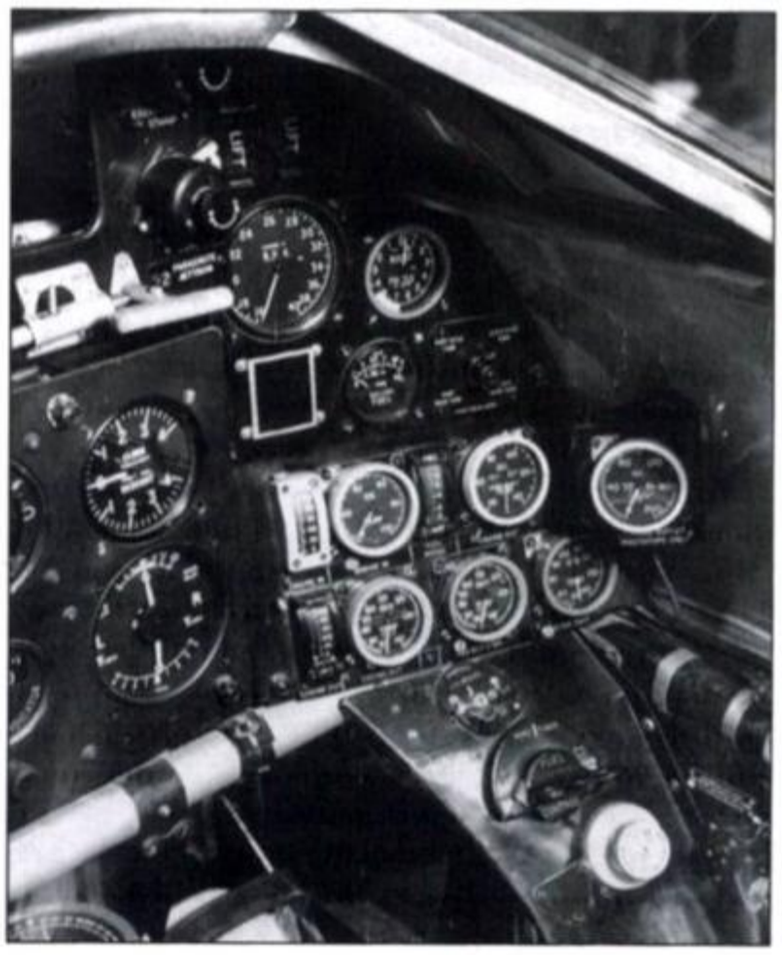
Where the two aircraft differed was in the positioning of their radiators and in the type of mounting used for their respective engines. The 'R-Type' (soon to be named Tornado) employed a similar radiator position to the Hurricane, beneath the fuselage midway between the wings. Its Vulture engine, unlike the Sabre, could not be mounted over the wing-spar connecting structure, with the result that the Tornado's front fuselage was extended a further 1 ft (0.3 m) forward and its wings mounted about 3 in (7.62 cm) lower on the fuselage than those of the Sabre-engined aircraft.

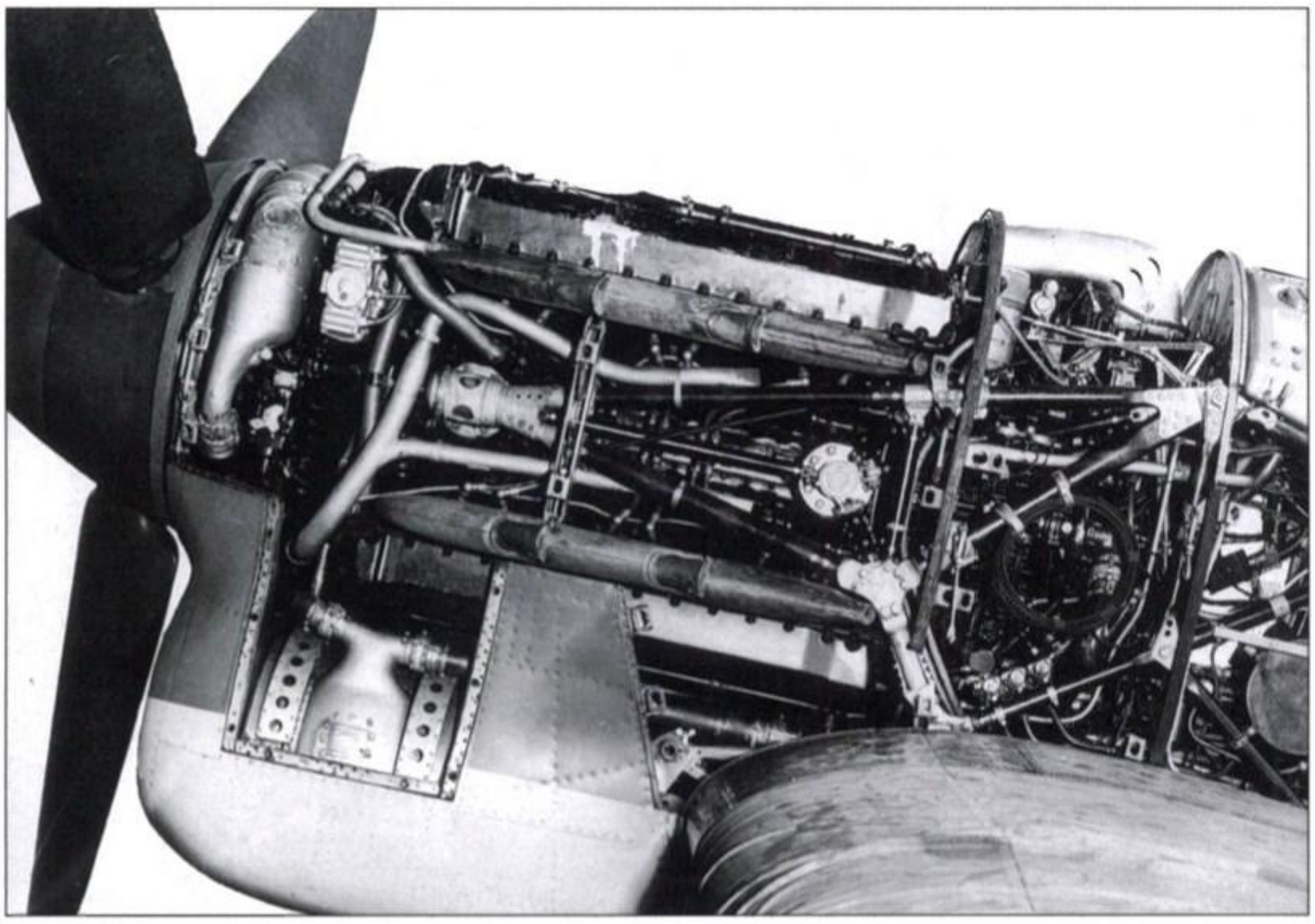
The 'N-Type' (later Typhoon) differed from the Tornado in having its radiator positioned beneath its nose, immediately aft of the airscrew, giving the aircraft a distinctive 'chin' that was to be a hallmark of the Typhoon and the Sabre-engined versions of its later Tempest derivative.

A Vulture II engine (the 18th example completed) was delivered to Kingston in December 1938, allowing work on the first Tornado (allocated the serial number P5219) to proceed apace and move ahead of that on the Typhoon prototype (P5212). In fact, the latter's Sabre engine was experiencing considerable development problems that would delay its first flight until February 1940.

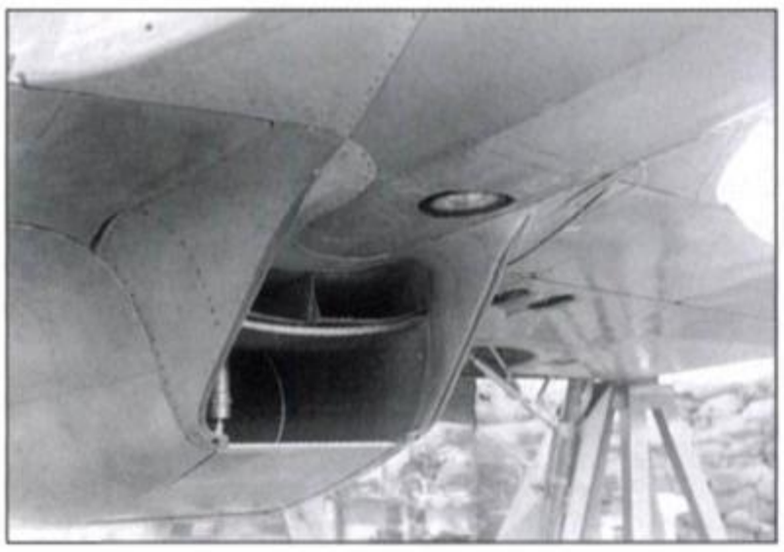
In July 1939 P5219 was moved by road to Hawker's new Langley factory for final assembly and test flying. Fitted with the Vulture II rated,

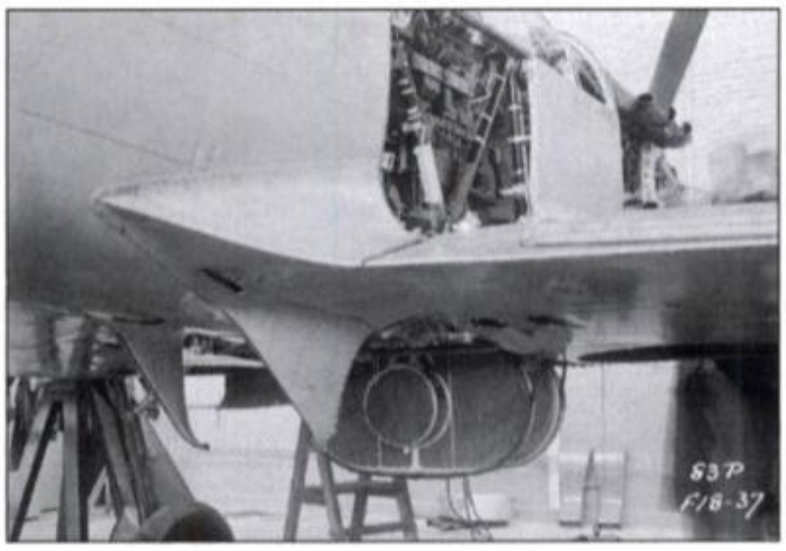
Cockpit layout was very similar to that of the Typhoon, with the main dials (including the air speed indicator, artificial horizon and altimeter) on a prominent central binnacle-type panel.





With an 'X' formation the Vulture had two banks of cylinders either side, each of which had a separate exhaust manifold. This accounted for the two rows of exhaust ports which most readily distinguished the 'R-Type' from the 'N-Type'.





Above and above right: The repositioned radiator intake, which also incorporated intakes for the carburettor and supercharger, provided an improved ram effect for the latter.

rather conservatively, at 1,760 hp (1312 kW), the unarmed P5219 weighed in at some 9,520 lb (4318 kg) – just over 4,000 lb (1814 kg) more than the Hurricane prototype. In this condition it took to the air for the first time in the hands of Philip Lucas on 6 October 1939. The aircraft's performance on those initial flights was promising, though at speeds approaching 400 mph (644 km/h) the compressibility effects that were to dog the Typhoon in service and, ultimately, limit its usefulness to altitudes below 25,000 ft (11340 m) became apparent. In addition, airflow around the ventral radiator was shown to reverse around the rear part of the housing, significantly increasing drag. Testing was therefore suspended while the radiator was repositioned under the aircraft's nose with a 'chin' intake very similar to that of the Typhoon and, with this alteration completed, flying recommenced on 6 December.

Meanwhile, at the end of December Hawkers at last received a Sabre I for installation in the Typhoon prototype and this was flown for the first time, again by Lucas, on 24 February 1940.

By this time the Air Ministry, having kept a close eye on developments at Langley, was sufficiently impressed with the potential of both designs to have issued an 'Instruction to Proceed' with preparations for full-scale production of 1,000 aircraft. As the Vulture seemed, at this early stage, to be the more promising of the two engines, 500 of these aircraft were to be Tornadoes and 250 Typhoons with the balance to be decided once production aircraft had been compared.

Production by A. V. Roe Ltd

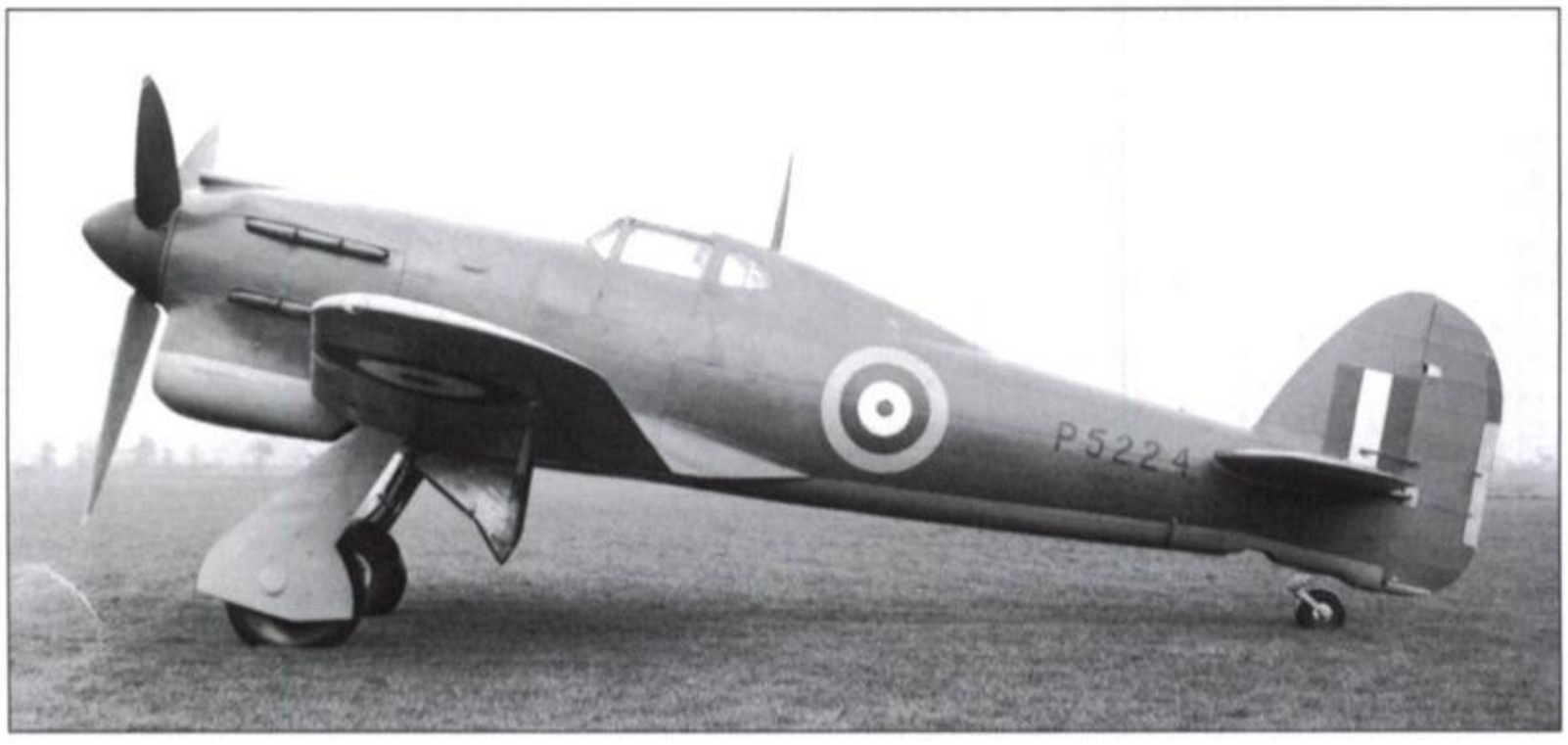
Where these machines were to be built was the next question. Hawker was so busy with Hurricane production that other factories within the Hawker-Siddeley Group would have to assist. Tornado production would therefore be the responsibility of A. V. Roe & Co. at its Yeadon, Leeds factory, while the Gloster Aircraft Company at Hucclecote, near Gloucester would build Typhoons.

Test flying and preparations for production continued into 1940, but suffered a setback in May when the Typhoon prototype P5212 suffered a major airframe failure. On 9 May, while being flown by Philip Lucas, the aircraft's rear monocoque failed at the point where it joined the centre section of the fuselage. Lucas was able to see daylight through a gaping hole in the starboard side of the fuselage, just aft of the cockpit, but managed to nurse the machine back to Langley for inspection and repair. For his bravery Lucas was awarded the George Medal.

Fortunately, from Hawker's point of view, production of both of the new fighters had been postponed by the Minister of Aircraft Production, Lord Beaverbrook, only a week before the accident. The production of five existing types, including the Hurricane, received priority as German forces rolled across France and looked likely to threaten Britain before long.

Although Typhoon P5212 was repaired and suitably modified to prevent a recurrence of the

P5224, seen soon after completion, flew with a 'chin' radiator from the outset.



A&AEE test flight, October 1941

Though cancellation was imminent, P5224 had been tested briefly at A&AEE Boscombe Down during October 1941. Weighing in at 10,690 lb (4849 kg), the aircraft was shown to possess handling characteristics indistinguishable from those of the Typhoon, with stall speeds of 82 mph (132 km/h) in 'clean' condition and 61 mph (98 km/h) with undercarriage and flaps down.

At high rpm (around 3,200) the Vulture V fitted to the aircraft was described as 'running rough' and although performance was comparable to that of the Typhoon, it was noted that the engine's maximum supercharger boost pressure was below par, running at +8 psi (55.16 kPa), rather than its designed +9 psi (62.06 kPa). Had maximum boost been available a top speed above 400 mph (644 km/h) would have been achieved; A&AEE pilots managed to coax 398 mph (641 km/h) out of the machine at 23,300 ft (7102 m).

It was noted that, while engine temperatures were satisfactory for operation in temperate climes, cooling problems would have been experienced in the tropics.

fuselage failure, it is not recorded whether these modifications were carried out on P5219, though it seems likely. However, some changes are known to have been made to this aircraft during the summer of 1940, the most significant of which was the enlargement of the rudder to improve the lateral stability of the aircraft – a problem that affected both the Tornado and the Typhoon.

A second Tornado (P5224), the completion of which had been delayed by the priority attached to Hurricane production, finally appeared towards the end of the year, taking to the air on 5 December. This aircraft embodied all the modifications made to the first machine with the addition of small side windows in the cockpit hood fairing, to improve rearward visibility. Provision was also made for revised armament, Specification F.18/37 having been changed to require the fitting of four 20-mm Hispano cannon (with 150 rounds per gun) in place of the somewhat inadequate rifle-calibre machine-guns.

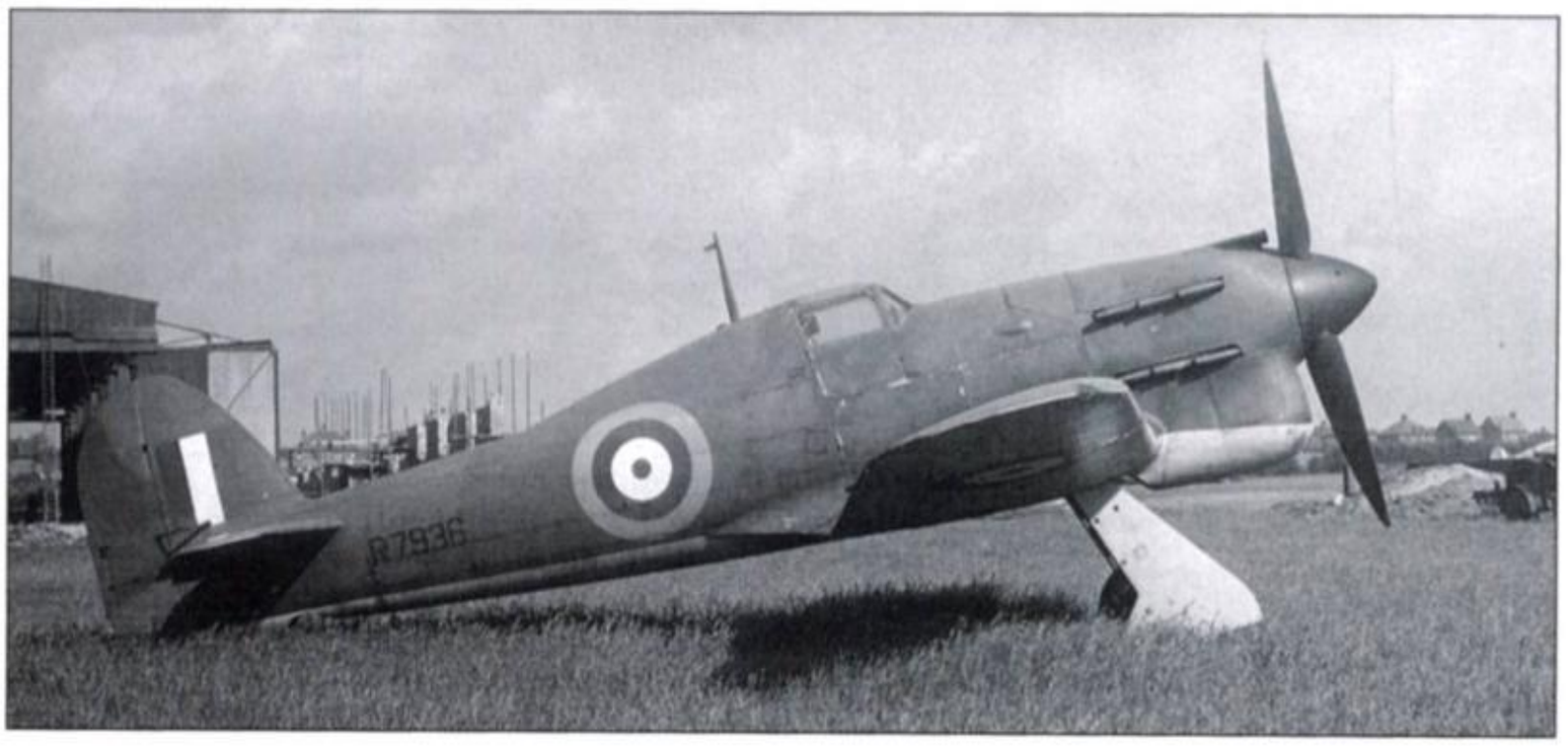
P5224 was a little heavier than the first aircraft, at 9,600 lb (4354 kg) and was, like P5219, powered by a Vulture II, though this was exchanged in March 1941 for a Vulture V rated at 1,980 hp (1475 kW). An example of this, the intended production variant of the Rolls-Royce engine, was also installed in the first prototype at about this time.

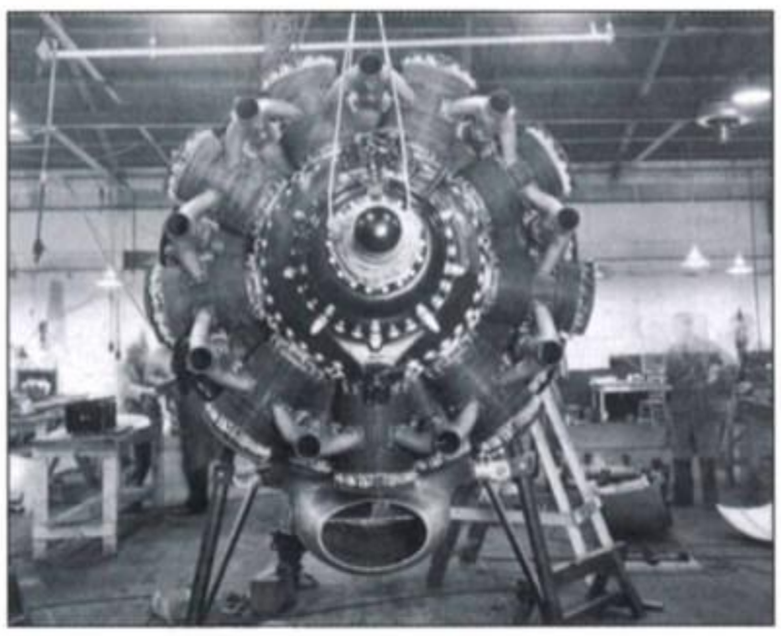
The Vulture had been authorised for production in March 1939, the Air Ministry having identified a need for no fewer than 1,560 examples. Despite this, in August, Rolls-Royce expressed the view that Vulture development, along with that of a number of other Rolls aero-engines, should be terminated so that the firm could concentrate on the production of proven engines like the Merlin. However, it was to be over-ruled by the Air Ministry, which stated that the Vulture was required to power both the Avro Manchester bomber and the Tornado, so development continued.

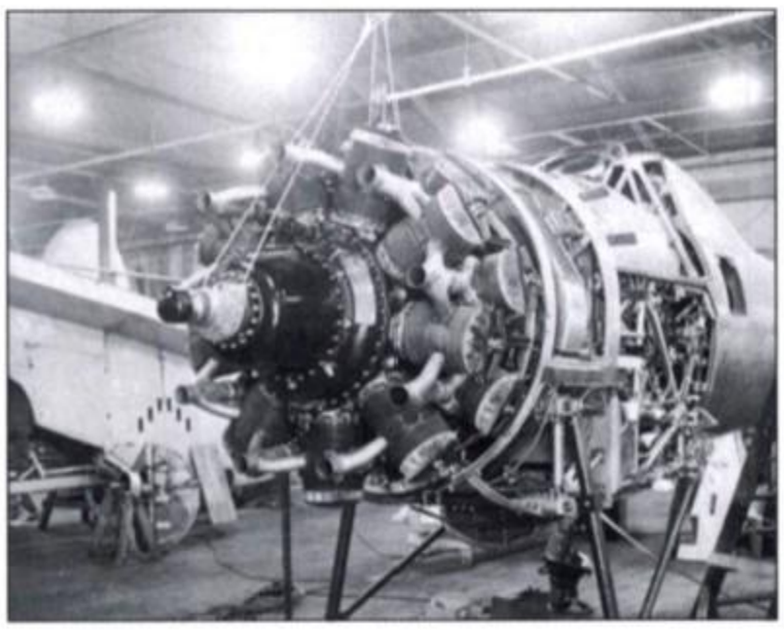
The Manchester was used operationally by RAF Bomber Command in February 1941 and it was the unhappy experiences of the seven squadrons so-equipped that brought the Vulture's weaknesses into sharp relief. Chief among these were coolant and lubrication problems (causing engines to overheat and catch fire), main bearing failures and connecting-rod bolt fractures, all of which contributed to an unacceptable loss and aborted sortie rate among the Manchester squadrons. The Vulture IIs fitted to these aircraft had already been derated slightly (from 1,820 hp/1357 kW to 1,760 hp/1312 kW) in an effort to bring about a reduction in failure rates, but this had failed to improve the situation. Compounded by inherent weaknesses in Avro's

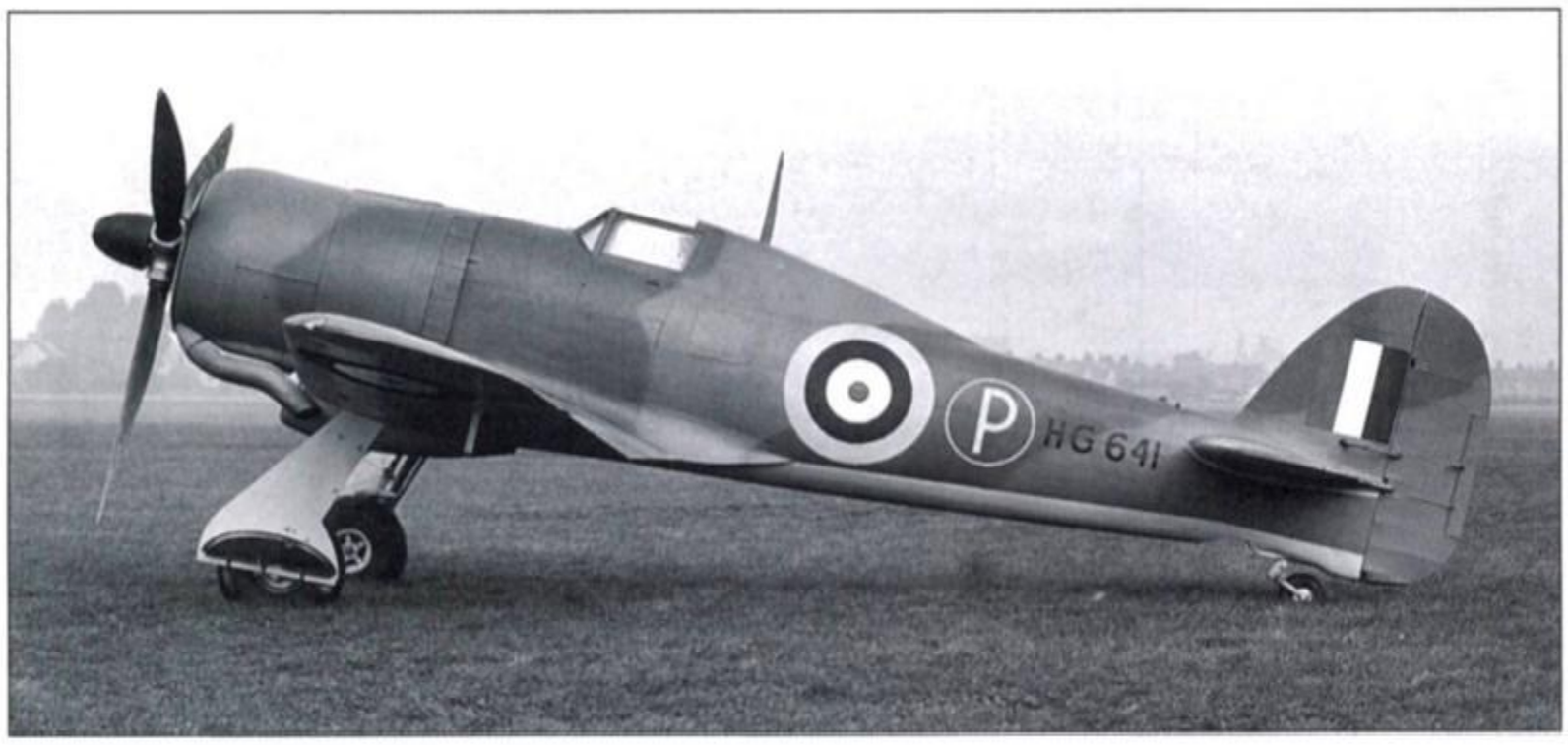
Above: Wearing its 'P for prototype' marking over a standard Dark Earth/Dark Green camouflage scheme, P5224 is seen during flight testing at A&AEE Boscombe Down in late 1941.

With the cancellation of production contracts, R7936, the sole Avro-built aircraft (below), became something of an orphan and was offered to de Havilland Propellers and Rotol Ltd for contra-rotating propeller testing. Both firms made use of the machine, Rotol employing the aircraft from its Staverton facility (bottom).









Above: These views show HG641 in the throes of construction, with Centaurus CE.4S No. 19 about to be mated to the airframe. The distance between the engine installation and its cooling gills is evident.

Above and left: Assembled at Langley from components manufactured by A. V. Roe & Co., HG641 was completed purely as an engine testbed. Here it is seen with the original Bristol Centaurus CE.4S installation with a conventional front exhaust collector ring, a single external exhaust pipe and a combined fairing for the carburettor intakes and oil cooler. Note that the cooling gills have been positioned aft of the more usual location behind the rear bank of cylinders to a position in line with the firewall. Early flights revealed an unacceptable vibration problem which led to complete redesign of the installation.

design this disastrous state of affairs led to the withdrawal of the Manchester from front-line service in June 1942.

Needless to say, alarm bells were ringing at Hawker and in January 1941 it was proposed to rework the Tornado to accept the 2,000-hp (1491-kW) Wright Duplex Cyclone Type C radial (known to the US military as the R-3350) in place of the troublesome Vulture. To this end much design work was carried out at Kingston, but the project was abandoned in July.

The following month the first batch of production Tornados was nearing completion at Yeadon. The first example, Tornado Mk IA R7936, took to the skies on 29 August. The third Mk IA, R7938, was despatched to Rolls-Royce on 13 September to assist in Vulture development but neither this aircraft nor three others nearing completion at Yeadon (R7937, R7939 and R7940) ever flew.

A cancellation order for Tornado production followed soon afterwards, with the ongoing set-backs effecting the Vulture cited as the main reason. Most of the engine's faults were put down to rushed development which had led to fatigue problems with, in particular, con-rod bolts. Interestingly, Vultures fitted to the Tornado prototypes gave little trouble and it was apparent that those fitted to the Manchester were performing under much more stressful conditions of sustained climbing flight in a heavily-laden aircraft. However, with Rolls-Royce under pressure to give priority to the Merlin and new Griffon engines, the Vulture was abandoned. Production finally ceased in June 1942, 538 Vultures having been completed.

However, this was not quite the end of the story, for the Tornado had a part to play in the development of a new powerplant and its installation in a Typhoon derivative that entered production as the Tempest Mk II.

In late 1939 consideration had been given to equipping the Tornado with the new Bristol Centaurus 18-cylinder, air-cooled radial engine. In order to demonstrate the feasibility of a Centaurus-powered aircraft P5224 was mocked-up in November with a Centaurus installation prior to being completed with a Vulture II powerplant. Six months later Bristol completed detailed design work and before the Tornado production contracts were cancelled a third prototype was ordered, in February 1941.

HG641 was completed at Kingston utilising surplus wings and rear fuselage components mated to a new front fuselage onto which was mounted a 2,120-hp (1580-kW) Centaurus CE.4S. The aircraft did not fly until 23 October and was far from satisfactory thanks to vibrations traced to the cowling design. Modifications were made and HG641 was flown once again but the changes made to the cowling design had evidently made little difference and when the engine's supercharger suffered a bearing failure the opportunity was taken to ground the aircraft pending more drastic alterations. In the meantime, the Air Ministry had seen enough promise in the Centaurus-powered Tornado for a pre-production batch of six machines to be ordered in early 1942.

Work on a redesigned aircraft began in February 1942, HG641 emerging from Kingston in November with an entirely new cowling with twin exhausts. A new CE.4SM engine was supplied, this one featuring a two-speed supercharger and driving a four-bladed propeller with an enlarged spinner fully enclosing its hub.

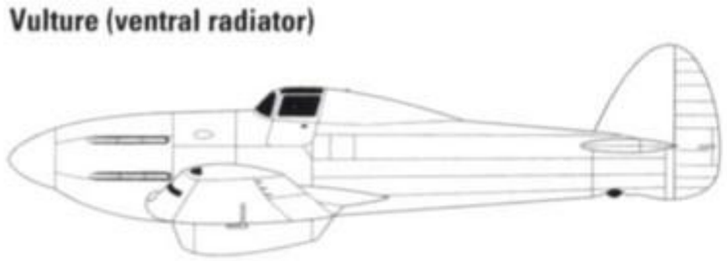
Flight tests resumed and during December HG641 made good on early disappointments by reaching a top speed of 402 mph (647 km/h) at 18,000 ft (5486 m). Promising though this performance was, the Tornado was always going to be hamstrung by the inadequacies of its wing and, by this time, other events had overtaken the Centaurus-Tornado programme; a Sabre-engined Tempest prototype (formerly known as the Typhoon Mk II) had flown in September and was to be followed by Rolls-Royce Griffon-

Specification

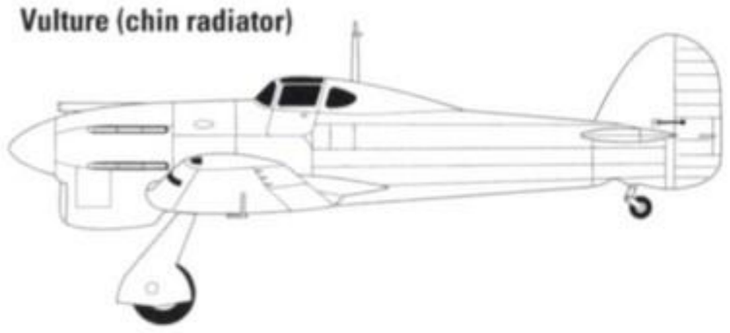
Powerplant: one 1,980-hp (1476-kW) Rolls-Royce Vulture V driving a 13-ft 3-in (4.04-m) diameter 3-bladed propeller or a 2,210-hp (1648-kW) Bristol Centaurus CE.4S driving a 12-ft 9-in (3.89-m) three- or four-bladed propeller
Dimensions: span 41 ft 11 in (12.78 m); length 32 ft 10 in (10.01 m); height (tail down) 14ft 8 in (4.47 m); wing area 283 sq ft (26.29 m²)
Weights: (Vulture engine) empty 8,377 lb (3800 kg); loaded 10,668 lb (4839 kg); (Centaurus engine) loaded 10,320 lb (4681 kg)
Performance: (Vulture engine) maximum speed: 398 mph (641 km/h) at 20,000 ft (6096 m); climb rate 7 minutes 12 seconds to 20,000 ft (6096 m); service ceiling 34,900 ft (10638 m); (Centaurus engine) maximum speed: 402 mph (647 km/h); climb rate 8 minutes 24 seconds to 20,000 ft (6096 m); service ceiling 32,800 ft (9997 m)
Armament: none carried though provision made for either 12 Browning 0.303-in machine-guns or four Hispano 20-mm cannon

Tornado configurations

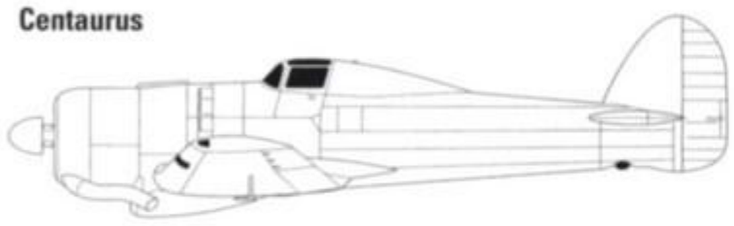
Vulture (ventral radiator)



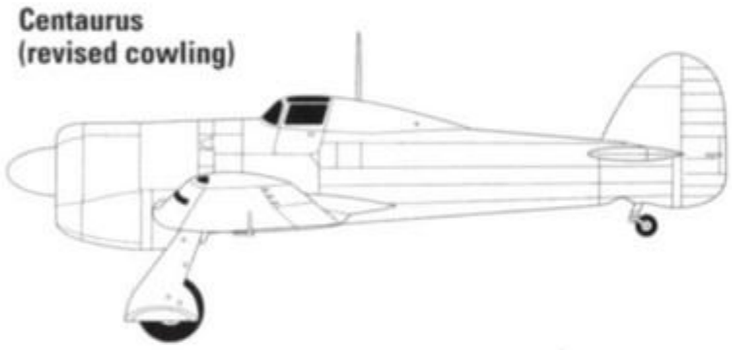
Vulture (chin radiator)



Centaurus



Centaurus (revised cowling)



and Centaurus-engined variants before long.

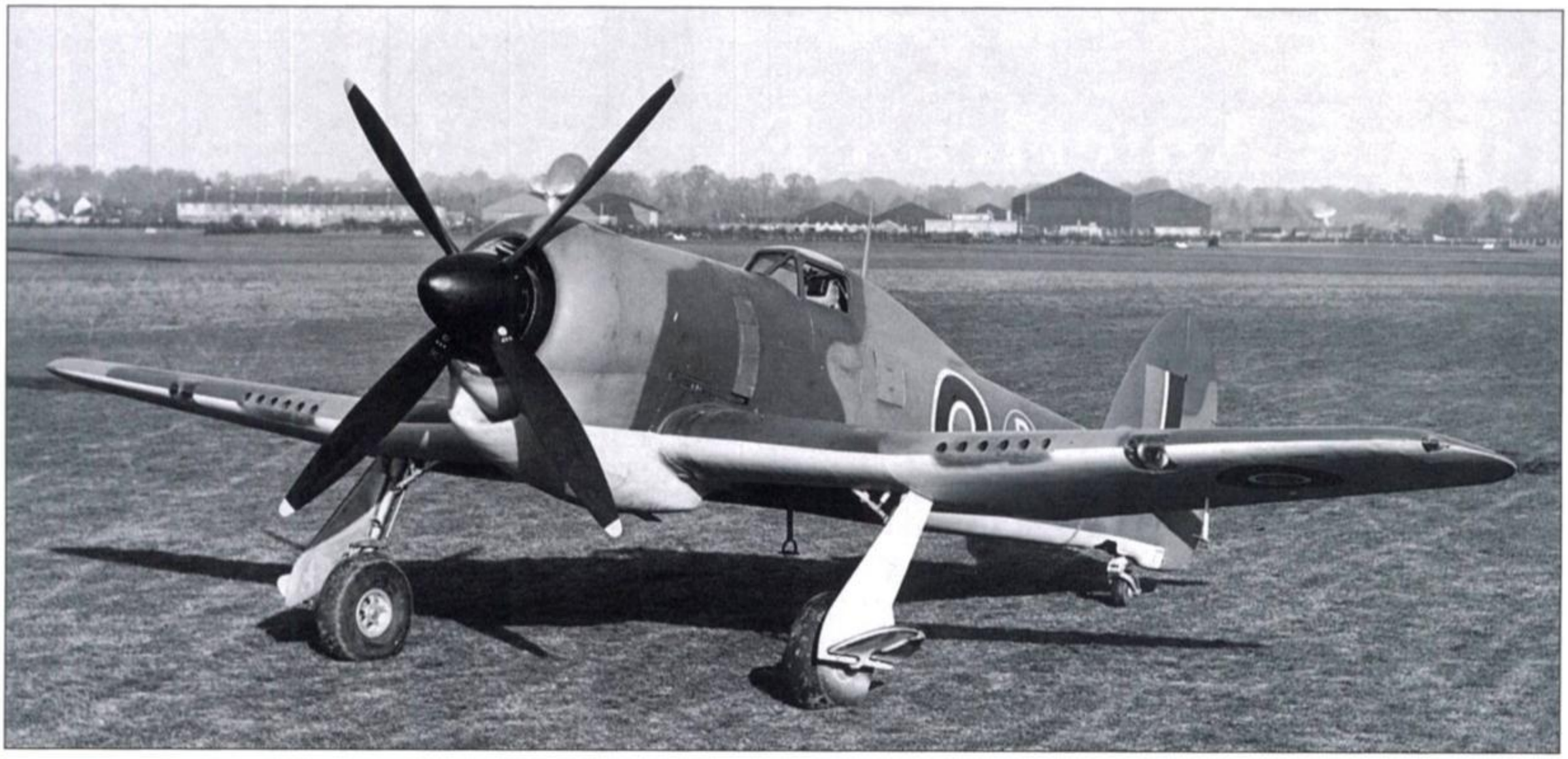
The six pre-production aircraft were cancelled in late 1942, even though a second Tornado fuselage had been modified to accept a Centaurus engine. On 3 February 1943 HG641 was sent to the Bristol aero-engine factory to assist in development of the engine for other applications and was to be the last airworthy Tornado, finally going for scrap in August 1944, when it was sent No. 43 Group (Maintenance Command).

Neither did the other three Tornadoes survive the war. P5219 was struck-off charge in August 1943 and scrapped, while P5224 was sent to RAE Farnborough for further trials in December 1941, remaining there until April 1943, when it was placed in storage at No. 20 Maintenance Unit at Aston Down. Finally, on 20 September 1944 it was despatched to the Salvage Centre at Oxford (No. 50 Maintenance Unit) where it was broken up.

The sole production Tornado Mk IA lasted almost as long as HG641. Its visit to Rolls-Royce in early 1942 culminated in modifications to its Vulture engine to allow the fitting of a contra-rotating propeller and by September the aircraft had been delivered to Rotol Ltd at Staverton for propeller trials. De Havilland Propellers Ltd at Hatfield also made use of the aircraft, though on 25 March 1943 R7936 was back at Langley where it remained until 1944. Another stint at de Havilland followed in early 1944, but by April the Tornado had been despatched to No. 43 Group; scrapping came shortly afterwards. It is believed that some attempt was made to save this airframe for posterity, but that this was defeated by a bureaucracy less than sympathetic towards the preservation of such items while the war continued.

So ended the story of the 'R-Type' F.18/37 prototype, an aircraft at least as promising as the Typhoon, which itself suffered engine problems at least as serious as those that afflicted the Vulture. Given the way in which the Typhoon was to be eventually employed, as a low-level ground-attack aircraft, one can only speculate as to the future of the Tornado – an aircraft powered by an engine that, although it had 'blotted its copybook' in the Manchester, appeared to perform with far fewer problems in the Tornado. **John Heathcott**

To address the vibration problems that plagued the first Centaurus-powered Tornado, the cowling underwent considerable redesign. This incorporated an integral exhaust system and though it benefitted from the examination of a Focke-Wulf Fw 190 captured in 1942, the final design was nowhere near as neat as that of the Luftwaffe fighter. Note also the four-bladed Rotol propeller and 12 machine-gun ports. Interestingly the aircraft retained the hinged undercarriage wheel covers fitted to the Typhoon prototypes, but not to the first two Tornados.



North American Rockwell A3J (A-5) Vigilante

Possibly the most handsome aircraft to operate from an aircraft-carrier, the A3J-1 was sold to the US Navy as a Mach 2-capable nuclear bomber with a capability years ahead of its time. However, plagued by problems with a weapons delivery system that would not work, cost overruns and a general complexity that caused maintenance nightmares, the Vigilante bomber's career was brief. One of the largest aircraft to operate from a carrier deck, this fact alone made the A-5A (as it became in 1962) unpopular with commanders, and a handful for careless or inexperienced pilots. When the controversial withdrawal of the US Navy's airborne strategic nuclear deterrent left it without a defined role, the future looked bleak for the A-5, but North American reworked the aircraft, giving it more fuel capacity and much improved engines. Although the new A-5B (formerly A3J-2) did not enter service (other than as a trainer) it formed the basis for a carrierborne tactical reconnaissance platform without precedent in terms of its capability. The new RA-5C remained peerless in carrierborne reconnaissance for 15 years, its spell of service spanning the difficult period of the Vietnam War, in which the Vigilante served with distinction. Upon its withdrawal in 1979 the US Navy did not have a replacement of comparable capability and, 20 years on, continues to lament the loss of its beloved 'Vigi'.

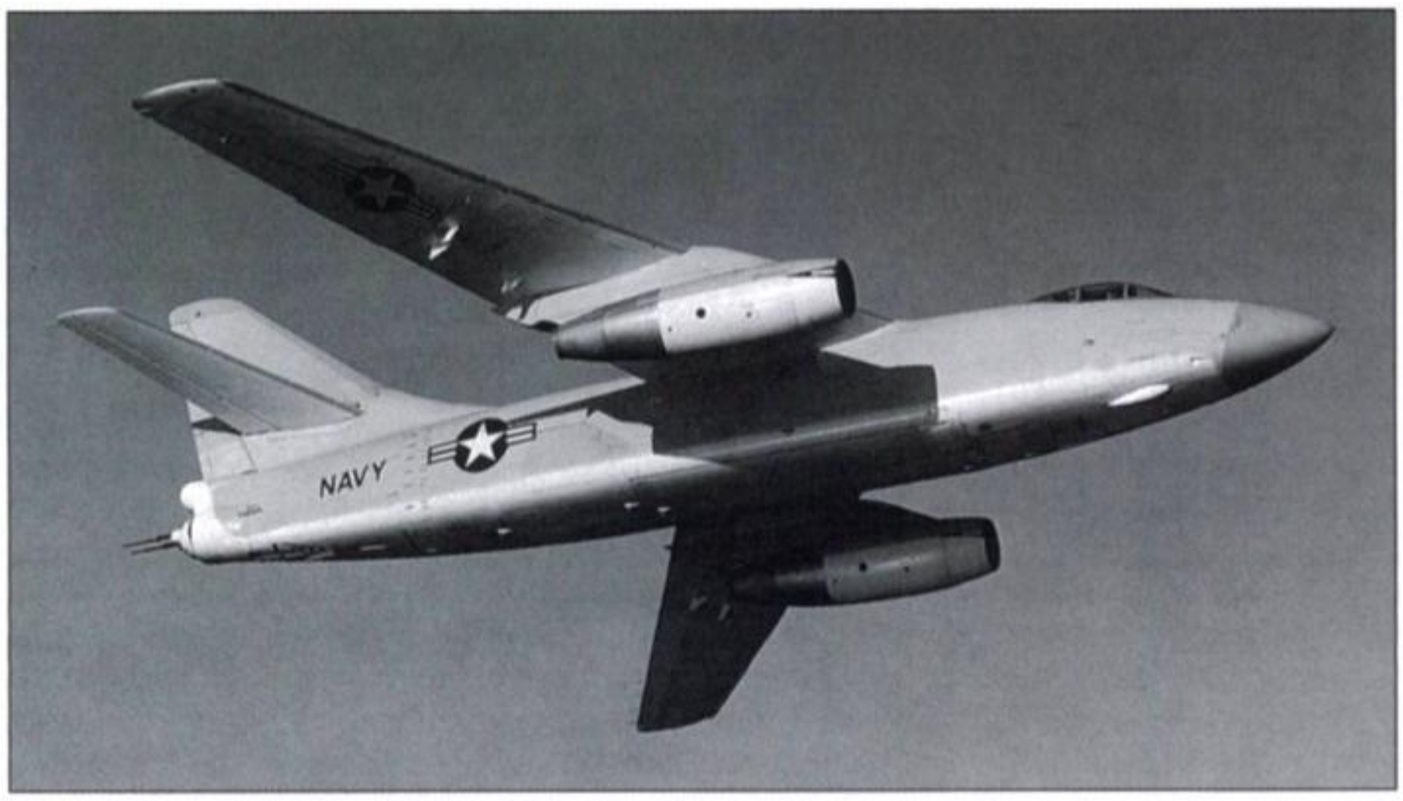
This pair of RA-5C Vigilantes of RVAH-3 (the Vigilante RAG) was among the 43 A-5A bombers converted to RA-5C standard for a new role as carrierborne reconnaissance platforms. Another 18 A-5Bs were converted to the same standard, bringing total RA-5 production to 140 aircraft, including 79 new-build machines.

The Bomb goes to sea

Right: P2V-3C Neptune BuNo. 122969 demonstrates a RATO take-off from NAS Glenview in 1952.

Below right: One of the original order of 55 AJ-1s, the first of which was delivered to VC-5 in September 1949, is seen here finished in the overall glossy Sea Blue scheme adopted fleetwide for operational aircraft in 1944.

Below: This 'Whale' is one of the first batch of A3D-2 Skywarriors. Fifty A3D-1s were completed, followed by 164 A3D-2s, the last 21 of which dispensed with the somewhat anachronistic radar-guided tail turret in favour of a DECM suite. By 1957, when the A3D-2 entered service, carrier-based aircraft were finished in Light Gull Grey, with glossy Insignia White undersurfaces.



Given the size of the first nuclear bombs, the US Navy needed a large aircraft from which to deploy the weapons and therefore initiated a search for a suitable machine. The result was a 1946 order for test examples of the North American AJ-1 Savage. In the meantime an interim platform was sought. The largest aircraft in the USN inventory at that time was the new P2V Neptune patrol bomber, so Lockheed was asked to modify a single P2V-2 and 11 P2V-3s for use as P2V-3C carrierborne nuclear bombers. With its gun armament and other equipment removed to save weight, the P2V-3C was given extra fuel tankage and equipped to carry a 8,900-lb (4037-kg) 14-kT Mk I atomic weapon. Between 1948 and 1950 a number of trials were carried out, including RATO-assisted flights from the carrier USS *Coral Sea* (CVB-43). The most demonstrative of these was perhaps the flight made on 7 March 1949, when a P2V-3C of VC-5 launched from *Coral Sea* off the Virginia coast, flew across the continent and dropped 10,000 lb (4536 kg) of dummy nuclear devices on a west coast range, returning to land at Patuxent River, Maryland. The Neptune solution was not an entirely satisfactory one (given the inability to store the aircraft below decks and the disruption such a deployment would cause to other operations aboard the appointed carrier) and the Navy was pinning its hopes on the AJ-1. The smaller Savage was far better suited to deck operations and, with a small turbojet installed to supplement its piston engines, was a good performer with a respectable bomb load. However, with the jet age dawning, the AJ-1's tenure with the Navy's strategic strike units was to be brief. In 1949 the Navy and Douglas Aircraft signed the first contracts that paved the way for the development of the A3D Skywarrior. First flown in 1952 and entering service, with the first Heavy Attack Squadron (VAH-1), in 1956, the interim A3D-1 (and more advanced A3D-2 of 1957) became the heaviest aircraft to operate regularly from US carriers, eventually equipping 11 squadrons at the peak of the USN's carrierborne nuclear capability.

The roar of engines pierced the Pacific night as the silver aircraft began rolling down the runway on Tinian in the Mariana Islands. At the tip of the test-tube-shaped fuselage, Lieutenant Colonel Paul W. Tibbets pulled back on the control yoke, prompting the mammoth B-29 Superfortress to break with gravity and climb skyward. It was 02.45 on 6 August 1945, and the aircraft named *Enola Gay* had a date with history.

Just over six hours later, the men aboard the heavy bomber caught their first glimpse of the target – the Japanese city of Hiroshima. Among them was a naval officer, not even an aviator but a surface sailor, seemingly out of place amid the Army Air Forces crewmen on the *Enola Gay*. Yet, the 43-year-old captain with the receding hairline was perhaps the most important man aboard the aircraft: he was tasked with arming Little Boy, the atomic weapon resting in the aircraft's bomb bay. Having completed his work, Captain William 'Deak' Parsons signalled Tibbets that the bomb was ready and at 09.09 authorised its release over the unsuspecting city below. Six minutes later, Little Boy fell free as Parsons whispered to himself, "Now it is in the hands of the gods."

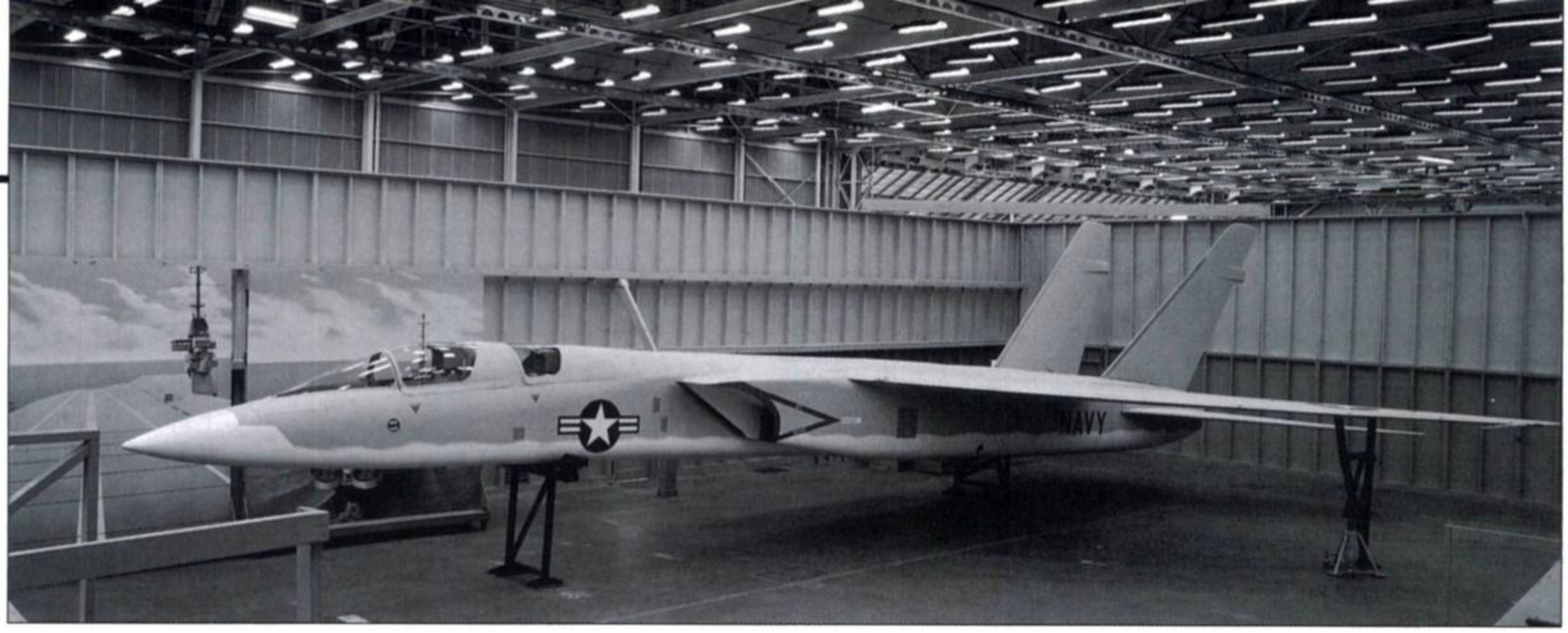
The mushroom clouds over Hiroshima and Nagasaki marked the funeral pyres of one world and the beacons for the beginning of another. They signalled the end of the most destructive war the world has ever known, but in helping bring about final peace, they triggered a Cold War in which the threat of nuclear war was the centrepiece. It was an era in which East faced West over the Iron Curtain, approached the brink of nuclear war in Cuba in October 1962, and jockeyed for position in a series of limited conflicts.

Not surprisingly in this defence climate, military forces around the world devoted exhaustive resources to waging an atomic war. Although in the United States the US Air Force took the lead when it came to nuclear weapons delivery, the Navy fought for and received a share of the vital mission, wedding it to the premier weapon to come out of World War II – the aircraft-carrier. In 1961, an aircraft that marked the pinnacle of the Navy's technological development joined the fleet. Sleek, fast and capable of launching from a flat-top to deliver its deadly payload anywhere in the world, the A3J Vigilante inherited naval aviation's atomic torch.

Yet, it was to be a short-lived reign, for the advent of submarine-launched ballistic missiles proved to be a more effective means of delivering atomic weapons. This development brought changes for the Vigilante. Ironically, an aircraft designed to deliver mankind's most deadly weapon was modified for use as an aerial reconnaissance platform. Instead of spearheading a decisive battle in the skies over the Soviet Union, it made a name for itself in a distant Cold War battleground called Vietnam. This is its story.

Roles and missions

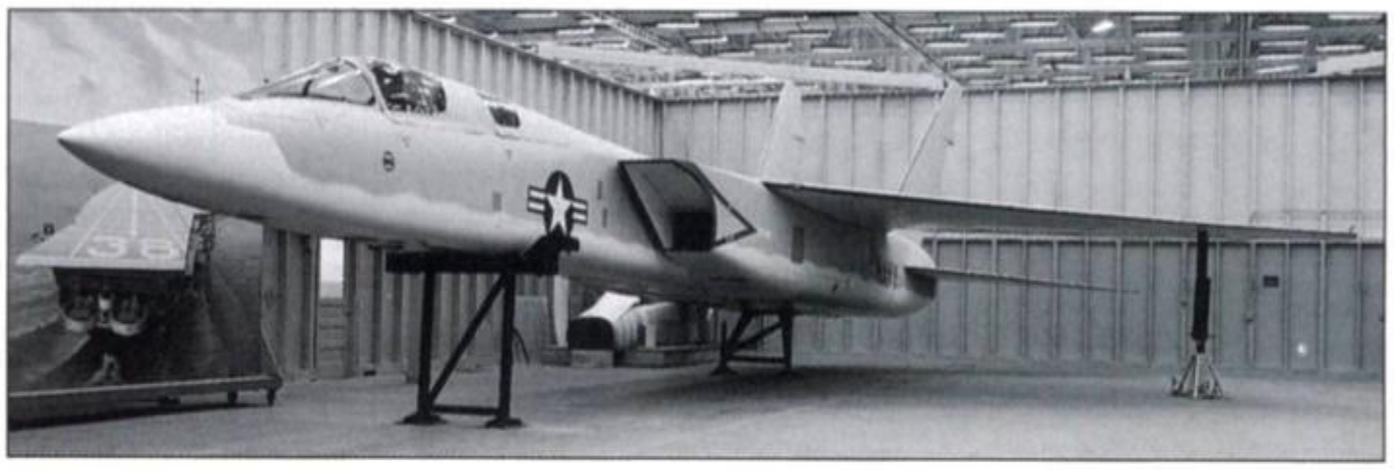
The participation of the US Navy in the mission of delivering atomic weapons almost never came to pass. During World War II the United States had amassed a war machine unparalleled in history, but when the guns fell silent in Europe and the Pacific, demobilisation came quickly. In addition, President Harry S. Truman sought a policy of economy and efficiency when it came to the military of the future. To this end, he championed the causes of unification, in which the armed forces were consolidated into a Department of Defense under a single



NAGPAW

Offered to the USN as an unsolicited proposal in 1954, the North American General Purpose Attack Weapon sought to address the two problems presented by the new LABS bombing system, as applied to the delivery of nuclear weapons – locating the target and escaping from a nuclear blast at low altitude. Suitably impressed, the Navy added two further stipulations in January 1955: that the aircraft have a zero-wind launch capability and that it be optimised for supersonic high-altitude penetration rather than the LABS delivery method originally envisaged. By then named Vigilante and soon to be designated A3J, North American's NA-233 proposal became the subject of an $86 million contract for two prototypes, awarded on 29 August 1956.

Though remarkably similar to the actual aircraft, the Vigilante mock-up of March 1956 was a twin-tailed design. Other major differences were in the navigator's cockpit canopy, engine intakes and linear bomb bay tail cone (the mock-up had clamshell doors).



cabinet-level secretary, and the creation of a separate US Air Force, both of which appeared in 1947.

Having been the primary instrument of strategic bombing during World War II, culminating in the atomic bombings of Hiroshima and Nagasaki, the upstart Air Force considered itself the nation's first line of defence, assuming the mantle long worn by the US Navy. In the minds of the air power disciples, the invention of nuclear weapons had changed the face of warfare. No longer would vast armadas duel at sea or large army groups struggle against one another on the plains of Western Europe. Instead, wars would be decided in the air with bombers seeking to destroy the war-making capabilities and terrorise the civilian populations of the enemy with nuclear weapons. "The ... Air Force is going to run the show," boldly proclaimed one general to a gathering of naval officers. "You, the Navy, are not going to have anything but a couple of carriers which are ineffective anyway, and they will probably be sunk in the first battle."

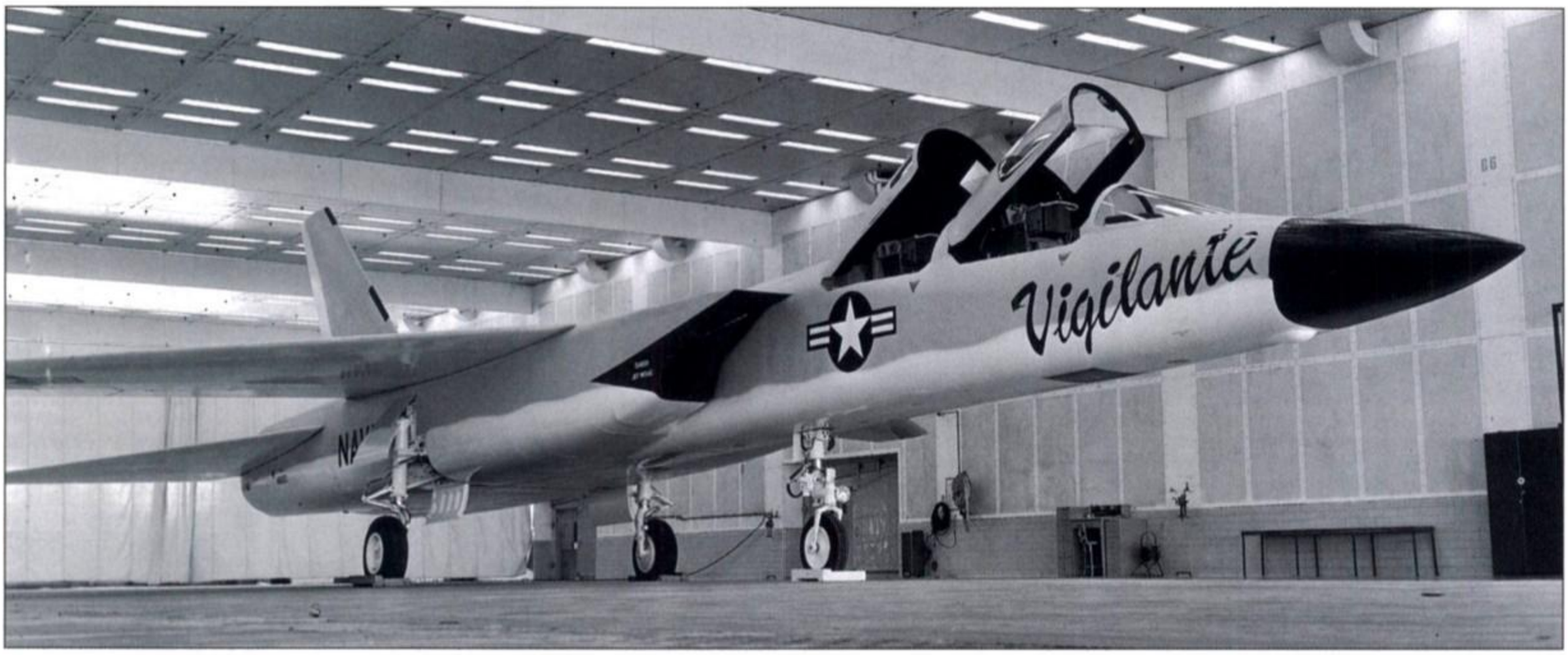
Carrier-based atom bombers?

Having fought to gain a place for themselves in a pre-war Navy dominated by the battleship, and finally come of age in the Pacific during World War II, naval aviators were not about to reduce their cherished aircraft-carriers to a secondary role when it came to the nation's defence. They argued vehemently against the Air Force's all-or-nothing strategy centred around the atomic bomb, instead believing that there was a place for tactical air power in future warfare, especially against naval targets. However, they realised the importance of the Navy having at least some role in the nuclear strike mission. One officer, Rear Admiral Daniel V. Gallery, went so far as to say that the Navy should develop large flush deck carriers and long-range aircraft that enabled the sea service, not the Air Force, to be the primary deliverer of the atomic bomb! Although the majority of naval officers did not take their argument this far, the Navy did gain authorisation for construction of its first supercarrier, USS *United States* (later cancelled by Secretary of Defense Louis Johnson), and proceeded with procurement of a carrier-based aircraft capable of delivering the atomic bomb.

The protracted struggle for primacy in the atomic mission, waged in the halls of the Pentagon and on Capitol Hill for much of the latter half of the 1940s, culminated in the so-called 'Revolt of the Admirals'. During Congressional hearings into procurement of the Air Force's B-36 bomber and the roles and missions of the armed forces, a parade of senior naval officers spoke out against the Air Force's concept of strategic warfare. They included Chief of Naval Operations Admiral Louis Denfeld, whose stand against the party line advocated by the Secretary of Defense and Secretary of the Navy resulted in his firing. Nevertheless, the Congressional report concluded that intercontinental strategic bombing was neither the sole element of the nation's air power or exclusive to the US Air Force. And in May 1951, Congress authorised construction of what would become the Navy's first supercarrier, USS *Forrestal* (CVA-59).

While the debates raged in Washington, naval officers in the fleet did not stand idle in their quest to take the atomic bomb to sea. Under the direction of Captain John T. 'Chick' Hayward, a scientific-minded naval aviator who during World War II had flown PB4Y-1 Liberators in the Pacific and later worked in the Navy's rocket development programme at China Lake, California, the Navy evaluated

Below: One of the main problems associated with North American's first NAGPAW proposal was the method envisaged for the aircraft's escape after deploying its nuclear weapon. It had been intended that the two linear bomb bay fuel tanks would carry hydrogen peroxide to fuel a rocket motor fitted to the rear tank. On a typical mission, this would have propelled the aircraft from 50,000 ft (15240 m) to 70,000 ft (21336 m) prior to reaching the IP. Tested by NAA and the NATC in this modified FJ-4R, the motor worked well, but the risks in handling the rocket fuel at sea were unacceptable.



By anybody's standards in the 1950s, and compared to the types in service with the USN at the time, the Vigilante was a particularly exciting-looking and futuristic aircraft. The huge, box-like rear fuselage was certainly a new departure and a feature mimicked in a number of later designs. Also much-copied later was the Vigilante's variable intake ramp system, which allowed the aircraft's engines to breath subsonic air at supersonic speeds. The large one-piece tail surfaces and innovative mainplane, with its system of spoilers and deflectors (in place of conventional ailerons) and blown flaps represented something of an aerodynamic tour de force. The early fly-by-wire system used to control them was also a novelty.

YA3J-1 prototype

Designed by a team led by Frank Compton the two YA3J-1 Vigilante prototypes took nearly two years to complete, engineering drawing release being granted in June 1956 and construction beginning in August 1957. The first of the two machines – BuNo. 145157 (originally ordered as an XA3J-1, but redesignated before completion) was rolled out in May 1958 and underwent three months of static and taxi testing before its first flight on 31 August, powered by a pair of YJ79-GE-2s.

the feasibility of operating P2V Neptune patrol aircraft from carriers. A capable aircraft, the P2V established its reputation in September 1946, when one named *Truculent Turtle* flew non-stop from Perth, Australia, to Columbus, Ohio, covering a distance of 11,236 miles (18082 km) in 55 hours and 17 minutes. Hayward demonstrated the aircraft's potential in nuclear weapons delivery in dramatic fashion on 1 March 1949, when he made a RATO (Rocket-Assisted Take-Off) from USS *Coral Sea* (CVB-43) off the coast of Norfolk, Virginia. Carrying a dummy load that simulated the weight of an atomic bomb, Hayward crossed the continent and returned to the East Coast without refuelling. In the meantime, the Navy converted P2V-3 aircraft for atomic delivery, removing non-essential ASW equipment and defensive armament, increasing the fuel capacity, and modifying the bomb bay to carry the 8,900-lb (4037-kg) Little Boy-type bomb dropped on Hiroshima. Additionally, on 9 September 1948, the Navy established VC-5, the first squadron devoted to what became known as the heavy attack mission.

While the P2V-3C served as a capable interim aircraft, the arrival of the North American AJ-1 Savage provided naval aviation with the first aircraft designed from the beginning with nuclear weapons delivery in mind. A high-wing monoplane, the AJ-1 combined two Pratt & Whitney turbo-supercharged 2,300-hp (1715-kW) R-2800-44W engines with a 4,600-lb st (20.45-kN) Allison J33-A-10 jet engine in the aft fuselage, the latter enabling carrier launches without the benefit of RATO. With a top speed of 471 mph (757 km/h) and a combat range of 864 miles (1390 km), the aircraft was capable of delivering a 10,300-lb (4672-kg) nuclear weapon. The first production examples joined VC-5 in the autumn of 1949. Given the Navy's urgent need for a carrier-based nuclear weapons delivery platform, especially in light of the roles and missions debates in Washington, the AJ was rushed through production and quickly made operational. Given this accelerated production schedule, the aircraft experienced its share of difficulties during its flight trials and operational deployments in the fleet, though modifications that appeared in the AJ-2/2P versions of the aircraft somewhat diminished the problems. Nevertheless, it was upon the wings of the Savage that naval aviation entered the atomic age and, more importantly given the focus of this article, that North American Aviation gained valuable experience and exposure in designing heavy attack aircraft.

In March 1956 the logical next step in the heavy attack

On 16 May 1958 the Vigilante prototype was rolled out at NAA's Columbus plant. The somewhat flamboyant nose titling was short-lived and was replaced before the first flight took place.

programme appeared in the form of the A3D-1 Skywarrior, a pure jet that was the brainchild of famed Douglas Aircraft Company designer Ed Heinemann. Nearly 17,000 lb (7711-kg) heavier than its predecessor, which prompted the nickname 'Whale', the swept-wing A3D-1 offered increased performance, with a top speed off 610 mph (982 km/h) and normal radius of over 1,000 miles (1610 km). This dramatic improvement came at a time when the heavy attack mission had become increasingly important in the minds of some naval officers. Though aircraft like the AD Skyraider and A-4 Skyhawk, employing the loft bombing manoeuvre, provided the carrier with low-level nuclear strike capability, the A3D represented the carrier's atomic punch. "I reiterate once more that the successful execution of the Sixth Fleet mission is dependent upon the availability of a delivery aircraft the equivalent, or better, of the A3D," wrote Vice Admiral C. R. Brown, Commander, Sixth Fleet. "We know we haven't the fighters operational today, the surface missiles in necessary numbers nor effective radar with which we can defend the force. We must then strike at the source of the threat to our survival. At the moment, only the A3D can do this best."

Half a world away, in Columbus, Ohio, North American Aviation, Inc. was already hard at work in hopes of building an aircraft that could do it better.

NAA – a tradition of success

North American Aviation, Inc. traced its origins to 1928, the date of its incorporation in Delaware, and by the late 1950s the company had achieved widespread fame within aviation circles and among the general public with a string of classic military aircraft. Thousands of pilots in both the Army Air Forces and US Navy learned to fly in the T-6/SNJ Texan, and Lieutenant Colonel James H. Doolittle and his raiders flew the company's B-25 Mitchell bombers in their famous raid on Tokyo in April 1942. Yet, it was in the field of fighter aircraft that North American made its greatest contribution to military aviation. In the skies over Germany, the P-51 Mustang turned the tide against the Luftwaffe during World War II, while the F-86 Sabre became the premier fighter of the Korean War, the master of 'MiG Alley'.

As mentioned above, the Navy chose North American as the designer of the first carrier-based aircraft ever built with the express purpose of delivering the atomic bomb. Although the jet-powered A3D Skywarrior replaced their design, company engineers did not lose interest in seeking to build better nuclear weapons delivery platforms.

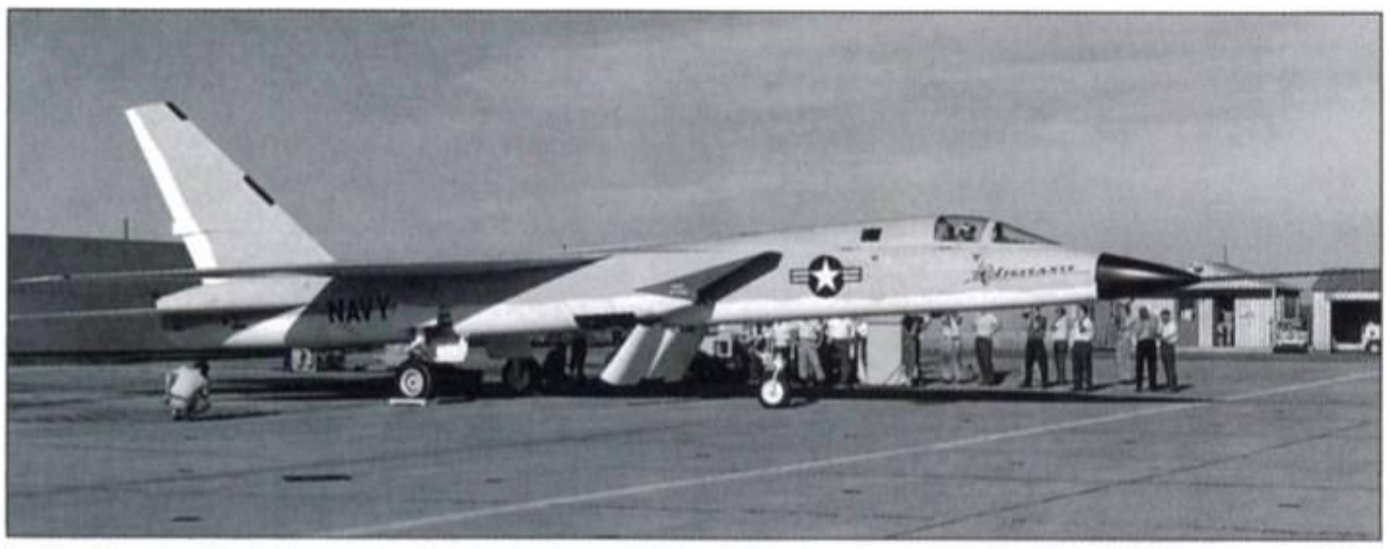
By the mid-1950s, a new tactic supplemented the traditional concept of high-altitude delivery of an atomic bomb using heavy attack aircraft. The advent of smaller-sized nuclear weapons enabled smaller carrier-based aircraft to carry them to the target. In this scenario, propeller-driven AD Skyraiders and A-4 Skyhawks, the latter a jet designed specifically as a nuclear-capable light attack aircraft, would proceed to the target at low altitude, avoiding Soviet radar. Reaching the target area, the pilots would pull back on the stick into a climb and release the weapon. Aerodynamics dictated that it would arc away from the aircraft and follow a downward-arced trajectory toward the target, allowing time for the pilot, completing an Immelman manoeuvre, to get away from the blast. Though appearing effective on paper, this toss bombing technique, called LABS in the Navy acronym (for Low-Altitude Bombing System), presented some problems. "We are fooling no one but ourselves if we believe that the AD can perform a low-altitude, low-visibility attack under wartime conditions," wrote one flag officer. "It cannot be used in all-weather conditions, there is no certainty that an accurate IP [Initial Point] can be located … and the over-the-shoulder method, if the target is located, will subject our bombers to heavy losses."

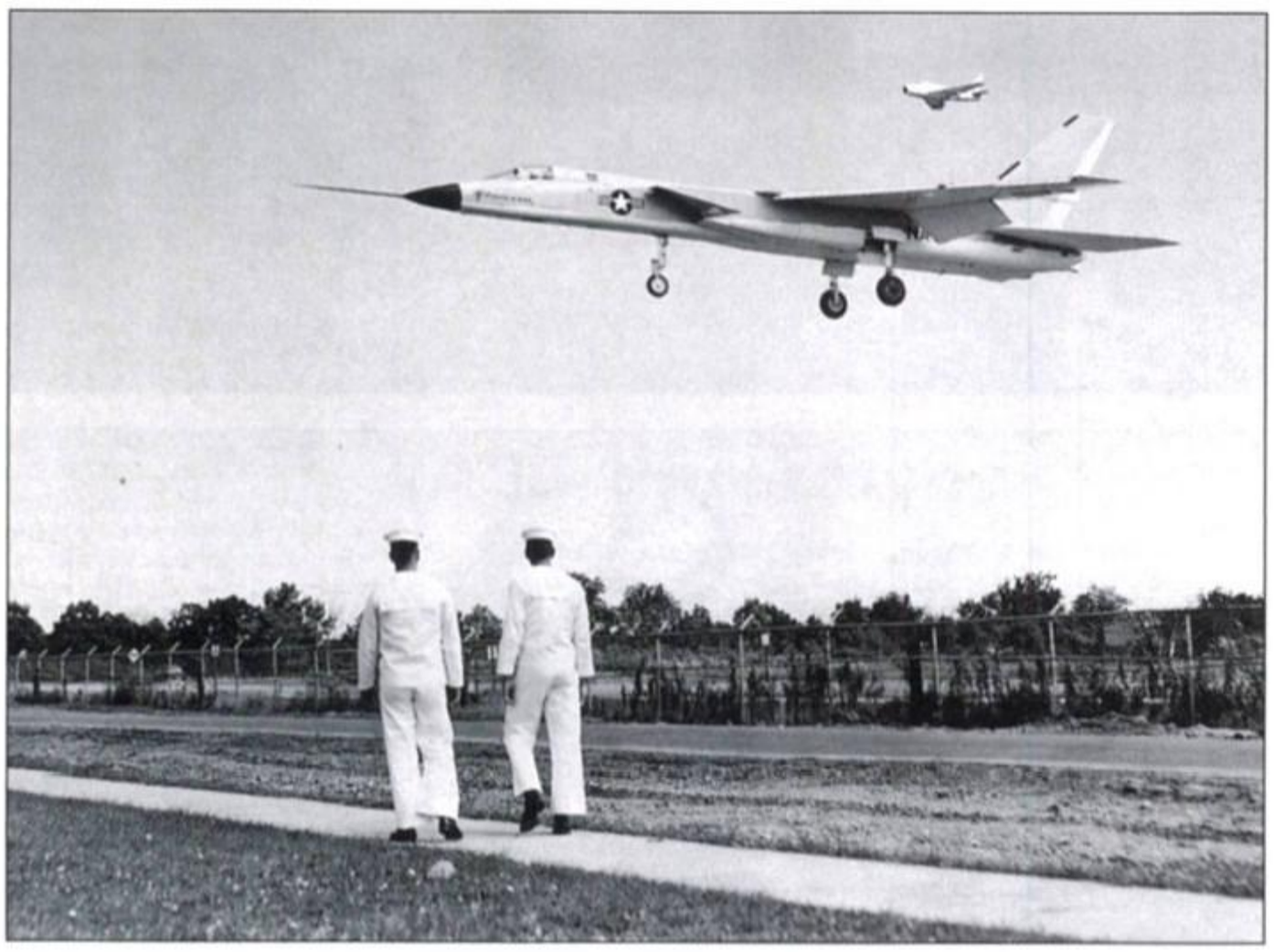
The factors expressed in this letter – accuracy, and the survivability of the attacking aircraft – prompted personnel at North American's Columbus Division in Ohio to initiate work on the design of an aircraft that would eliminate these

Above: Powered by a pair of General Electric YJ79-GE-2 engines, the first YA3J-1 took to the air for the first time on the last day of August 1958, in the hands of chief company test pilot Dick Wenzel. Wenzel is seen here, in the cockpit of the aircraft, chatting with another member of the NAA flight test team.

Top: Standing before the well known neon signs that advertised North American's first and most famous jet products, the first Vigilante is seen shortly after roll-out in May 1958.

A3J/A-5 Vigilante





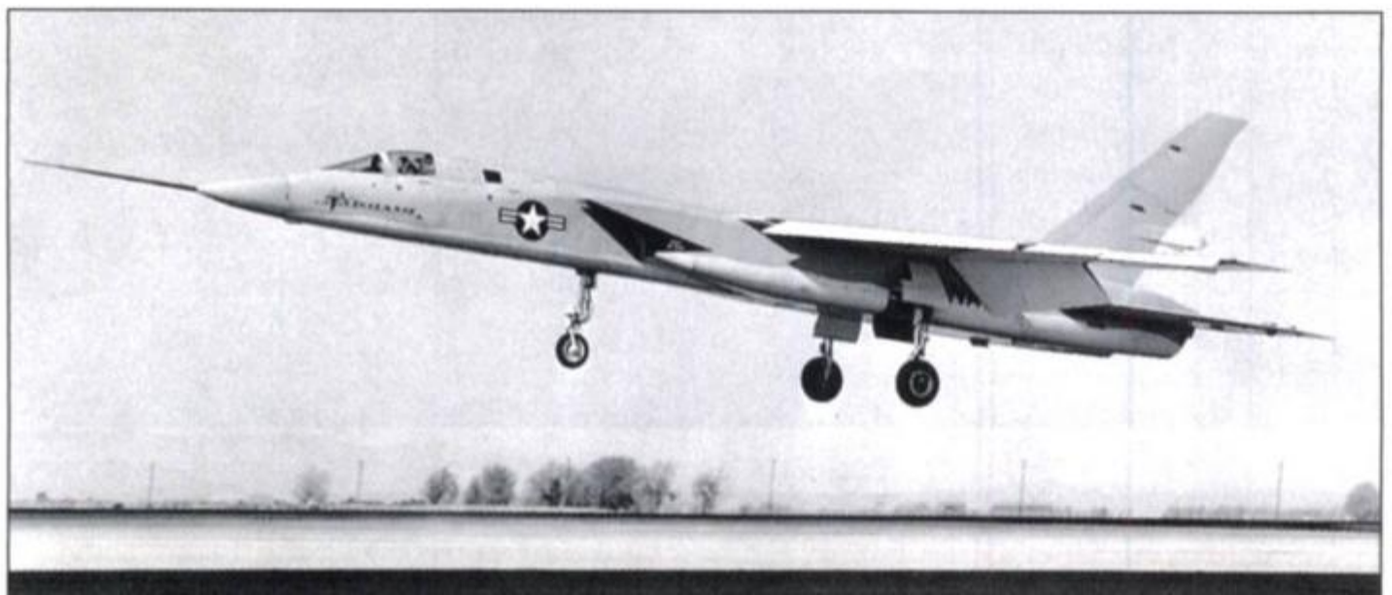
Above: Accompanied by North American's FJ chase aircraft, the Vigilante prototype lands after its first flight.

Top: Final preparations are made for the YA3J-1's first flight. Note that a test instrumentation probe has been fitted to the aircraft, which now carries 'NAVY' titles. The 'Vigilante' legend on its nose has also been replaced with a different version incorporating the NAA logo.

Below: The second YA3J-1 (BuNo. 145158) suffered hydraulic and electrical systems failure and was lost on 3 June 1959. Engaged in control systems tests, it completed 49 flights totalling 66.4 hours.

problems. Proceeding without the umbrella of a formal call for design proposals by the Navy's Bureau of Aeronautics, usually the first step on the road to production of a naval aircraft, in November 1953 the engineers initiated work on what came to be called the NAGPAW (North American General Purpose Attack Weapon). Under the direction of engineer Frank G. Compton, the company's chief designer, the aircraft began to take shape as a pure jet, a sharp contrast to the A2J turboprop design that North American had proposed a short time earlier as a replacement for the AJ.

Central to the development of the design were the North American team's solutions to the aforementioned difficulties in nuclear weapons delivery. Tackling the question of accuracy, the engineers proposed equipping the aircraft with an inertial navigation system linked to a radar and television sight. During an actual attack mission, this equipment translated into an extremely accurate target acquisition. Operating under the assumption that most targets inside the Soviet Union could be identified in relation to shoreline checkpoints on the ingress route, the typical mission profile began with alignment of the system before launch from the carrier. Key target data, including distances and a pre-selected co-ordinate position, were also entered into the system and were visible on the auto-navigator instrument panel in the cockpit. As the aircraft made its way toward the target, approaching a position approximately 15 miles (24 km) from the programmed checkpoint, the auto-navigator would begin its search for the checkpoint. Once it had been located by the pilot or navigator, either using the equipment or visually, and the aircraft crossed the checkpoint, the inertial navigation system was calibrated. Even as the aircraft flew 'on the deck' at extremely low altitude to avoid detection by enemy radar, the auto-navigator was capable of steering it automatically or indicating to the pilot the correct path to the target.



Linear bomb bay

Upon reaching the target, either automatically or with the pilot executing the manoeuvre, the aircraft would pull up into a vertical climb to release the weapon. At this juncture, another unique feature of the aircraft came into play, namely the linear bomb bay. Compton and George R. Gehrkens, chief engineer at the Columbus Division, recognised certain disadvantages in employing a conventional bomb bay aboard the aircraft. An elaborate system of sway bracing and suspension systems, coupled with fall clearance space, internally retractable doors and a close-out platform, produced extra weight. Additionally, supersonic aircraft devoted to the atomic mission were required to release their weapons at critical altitudes, and a conventional bomb bay did not guarantee weapons separation. Compton and Gehrkens decided to eliminate these concerns by locating a linear bomb bay between the aircraft's twin jet engines. Cylindrical in shape, it contained enough space for the tandem configuration of a nuclear weapon attached to a fuel container and an aft fuel can filled with over 2,000 lb (907 kg) of JP-4 jet fuel. When the time came for bomb release, a clam-shell door (later changed to a blow away cone) opened and the bomb was ejected aft by an internal store ejection gun. The by then empty fuel tanks attached to the weapon provided stability as the bomb arced towards the target. To assist in a successful delivery, provisions were made for inclusion of a countermeasure device in the bomb bay that could be ejected before the atomic weapon.

The attributes of this innovative system were not only apparent in the delivery of an atomic weapon, they benefited the overall design of the aircraft as well. The location of the linear bomb bay and fuel tanks created a very dense fuselage arrangement. Up to 150 cu ft (4.2 m^3) of space, normally allocated to the sway bracing and other equipment mentioned above, was saved. Additionally, by employing the empty fuel cans to stabilise the atomic weapon, the space normally required by the weapon tailcone and stabilising fins could be used for fuel.

Ideally, the ordnance load was released approximately 18.3 seconds after the aircraft pulled into a vertical climb and from an altitude of approximately 9,660 ft (2944 m). His deadly load released, the pilot pulled the aircraft into the inverted position and rolled out for egress from the target area, which was hastened by the aircraft's two General Electric J79 afterburner-equipped turbojet engines. During egress, the auto-navigator could be employed to assist in finding the position of the aircraft-carrier.

During the course of the design development, engineers also experimented with a rocket booster unit that provided an alternative delivery method. They attached a bi-propellant rocket motor to the aft-most fuel tank in the bomb bay. Fuelled by JP-4 from the aircraft's fuel system and fed hydrogen peroxide from the bomb bay fuel tanks, it allowed the aircraft to approach the target area from an altitude of 70,000 ft (21336 m), travelling at over Mach 2. When the hydrogen peroxide in the tanks was depleted, the rocket engine was jettisoned and the weapon ejected aft in the same manner as in the low-level delivery. An FJ-4R

Fury demonstrated the potential of this system on a test flight, achieving Mach 1.4 in reaching an altitude of over 70,000 ft, far in excess of the normal operational parameters of that particular airframe. However, the Navy baulked at the potential risk of carrying and handling large amounts of hydrogen peroxide aboard ship.

Back to the drawing board

By January 1954, an initial design incorporating the features outlined above was ready for presentation to the Navy, which greeted the twin-engined aircraft with much enthusiasm. Just five years removed from the 'Revolt of the Admirals', the service still sought to expand its nuclear capabilities. As one officer opined during that time, "Our planners in the Pentagon, aviators and non-aviators alike, are slowly beginning to realise the absolute necessity of pushing our atomic readiness at the expense of so-called conventional readiness." NA-233, as the North American design was called, represented a leap for atomic readiness.

Though pleased with the overall aircraft design, the Navy did change its mind about the aircraft's mission, which necessitated some changes in NAGPAW. Frank Compton recalled its effect on the aircraft. "The original NAGPAW was designed as a low-level penetrator. The wing geometry was selected accordingly. The wing area, however, was set by zero wind catapult requirements and the resulting wing loading was too low for acceptable ride qualities. During the second design iteration process where trade-offs – ride qualities vs. wind-over-deck requirements – were being studied, OPNAV changed the ground rules, making high-altitude Mach 2 penetration primary and low-level capabilities secondary. This change occurred in January 1955."

A variable-sweep wing would have been ideal to meet the high-speed and launch requirements outlined by the Navy, but memories of the failure of the technology in Grumman's XF10F-1 Jaguar ruled it out. The Navy would have to wait for the F-14 Tomcat to find a successful 'swing-wing' carrier aircraft.

Instead, Compton and his fellow designers settled on a wing swept at 37.5° and encompassing an area of 769 sq ft (71.44 m^2), which allowed Mach 0.95 at sea level and Mach 2 performance at 40,000 ft (12192 m). In addition, it almost met the Bureau of Aeronautics' lift requirements for a zero wind carrier launch. The wings also proved innovative in its lack of ailerons, their function assumed by a series of spoilers hinged along the leading edges of the wing and deflectors arranged along the trailing edges. Originally designed with twin vertical stabilisers, in final form the aircraft featured a single vertical tail surface, the size of which made it one of the more prominent features on the aircraft. Such was its height that it had to be folded downward for storage aboard ship, which reduced the height of the nuclear bomber by nearly 4 ft (1.2 m).

On 29 June 1956 North American received a letter of intent from the Navy, followed three months later by a formal contract for two prototypes. Proposed by the manufacturer, the new name for the aircraft, initially designated XA3J-1 (later changed to YA3J-1), was Vigilante.

Taking flight

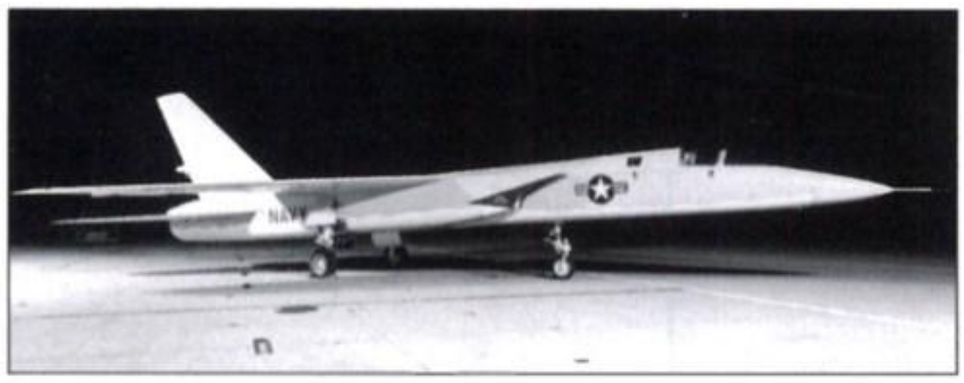
It took just over two years to ready the Vigilante prototype for flight testing. A North American Development Bulletin of 25 August 1958 outlined the progress in the design on the eve of the first test flight. In testing during the previous four months, it proclaimed, the YJ79-2 engine and engine test cell registered satisfactory performance throughout the full power range. In addition, testing was completed on all surface control systems, doors and other critical components in anticipation of the aircraft's maiden flight. The newsletter also announced that although the aircraft in which it was to be installed had not yet touched the clouds, the bombing-navigation system on which the Vigilante would so heavily rely performed well on 32 test hops. Installed in an Air Force RB-66 bomber, the system recorded only a 3-mile

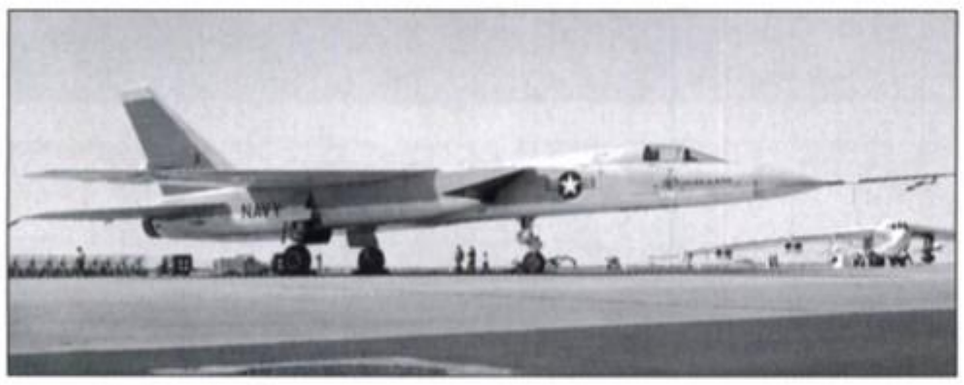
Above: During the initial Vigilante test programme, the prototype (distinguished by its black radome) was engaged in powerplant and spin testing. By 1 March 1962 it had racked up 307 flights with a combined duration of 433.6 hours.

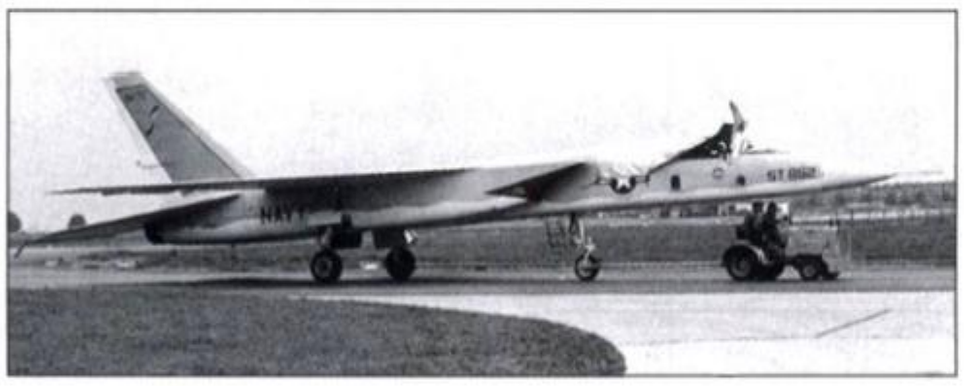
Top: Later in the test phase, BuNo. 145157 was sprayed with large areas of Dayglo to aid conspicuity. The aircraft eventually joined the RA-5C conversion programme but did not join an operational squadron. Retired to the MASDC at Davis-Monthan AFB in the early 1970s, it was moved to a USAF range in Nevada in 1986.

NATC trials

By mid-1959 the surviving Vigilante prototype and the first nine A3J-1s had entered the flight test programme at the Naval Air Test Center (NATC), Patuxent River, Maryland. The next five production aircraft followed the earlier machines to the NATC shortly afterwards and, by March 1962, most airframes had clocked up an average of around 300 hours flying time. Exceptions were BuNo. 147851, stricken at Patuxent River on 11 January 1961 (reason unknown) and BuNo. 146700, from which a LCdr Grimes was forced to eject on 17 March 1961. One of these aircraft remains and is the oldest surviving Vigilante. BuNo. 146697 became a gate guardian at Pax River, but has since been passed to the Naval Air Test and Evaluation Museum, which also has the final production RA-5C, BuNo. 156643.







***Above:** The pilot of BuNo. 146700 (with NATC tail markings) keeps a wary eye on the camera ship as he cruises along the coastline near Patuxent River sometime prior to the aircraft's loss in early 1961.*

***Upper right:** BuNo. 146695 was the subject for a night-time PR photo session prior to joining the test programme in a specific bombing and navigation test role. '695 was later converted to RA-5C standard along with nine other examples from the first 16 constructed.*

***Above right:** With a Hound Dog-toting B-52 in the background, BuNo. 146694 (identified on its tailfin as the third example) poses during a static display, believed to be at Edwards AFB in 1961.*

***Right:** Service test airframe BuNo. 147852 is towed to its parking spot after arriving at Le Bourget for the 1961 Paris Air Show, the first public appearance by the type overseas.*

The third production A3J-1 was chosen to test the type's North American HS-1 ejection seats. These were only effective at speeds above 100 kt (115 mph; 185 km/h) and were superseded in late-production A-5As and all A-5Bs/RA-5Cs by the HS-1A with zero-zero capability. Here BuNo. 146696 is shown during seat testing.

brakes at the end of the runway, the veteran test pilot selected maximum afterburner thrust and with a burst of acceleration the YA3J-1 thundered into the air at 150 kt (277 km/h) after a take-off run of approximately 2,500 ft (762 m).

Over the course of the hour-long flight, Wenzel found little that disappointed him. During a climb from 10,000 to 35,000 ft (3048 to 10668 m), he noted that lateral trim sensitivity was high, and when he extended the speed brakes during a shallow dive, moderate buffeting of the airframe occurred. He encountered the only major problem of the flight while evaluating performance at low speeds. Alternating between 40° and 50° of flap, Wenzel reported that lateral control responses for small deflections was low. The chase pilot also noted moderate flap-horizontal stabiliser buffeting. "The tips of the horizontal stabilisers were oscillating through a double amplitude of 1 to 1½ inches with flaps at either 50° or 40°, Wenzel wrote in his report of the test flight. "Very little flap movement was detected, indicating (4.8-km) error during a 1,500-mile (2414-km) round trip flight between Los Angeles, California, and Medford, Oregon. Immediately following this lengthy flight, the aircraft was flown from Los Angeles to El Centro, California, and back, without adjusting the system. The peak error after eight hours of operation was 6 miles (9.6 km).

Although scheduled for 30 August 1958, the first flight of the A3J did not occur until the following day when Dick Wenzel, North American's chief test pilot, climbed into Bureau Number 145157 for the maiden flight of the first Vigilante prototype. Weighing 46,400 lb (21047 kg), the aircraft was fitted with instrumentation installations capable of simultaneously recording 260 parameters in flight, providing engineers with valuable technical data. Wenzel found the cockpit comfortable and well related to the primary and secondary controls, and considered the visibility over the nose and to the sides to be excellent. Releasing the

***Above:** This unidentified member of NAA's A3J flight test team has just 'suited-up' and prepares to board the second YA3J-1 at Palmdale, California. He wears a B. F. Goodrich Mk IV full-pressure suit of the type used by NATC crew Cdr Leroy Heath and Lt Larry Monroe during their world altitude record-breaking flight of 13 December 1960. In this aircraft the pair reached 91,451 ft (27874 m). Earlier in the year, on 6 June, noted aviatrix and then-president of the FAI, Jacqueline Cochran, became the first woman to fly at Mach 2, when she occupied the RAN's seat on a high-speed run by a Vigilante over southern Ohio during which the aircraft reached Mach 2.02. Both flights served to underline the capabilities of the aircraft at a time when Congress was beginning to examine the huge costs and systems problems dogging the A3J programme.*

Bearing the stylised 'W' marking of the Weapons Test Division of the NATC, A3J-1 BuNo. 147859 rests between sorties, a dummy Mk 84 iron bomb suspended from its starboard pylon.

that the buffet was due to [the] horizontal stabiliser."

As for landing an aircraft of the Vigilante's size, Wenzel experienced high longitudinal control forces, but found the engine so responsive to small throttle movements that it made controlling the aircraft's sink rate less difficult. Speed control also proved satisfactory during landing approach. All told, Wenzel noted 12 malfunctions ranging from fire doors that would not close during the flight to spongy brakes to a canopy that took three attempts to lock. However, most could be classified as minor, with the only major concern being the flap-horizontal stabiliser buffet that he encountered at low speeds. During the flight, the aircraft reached a maximum speed of Mach 0.95 and climbed to 35,000 ft (10668 m)

Subsequent test flights continued into September and October, with the A3J-1 increasingly expanding the operational envelope. On 5 September the Vigilante reached 40,000 ft (12192 m) and Mach 1.1. Four days later maximum speed increased to Mach 1.4. In addition, low speed evaluations continued with landing gear and flaps, the aircraft operating at 20,000 ft (6096 m) and 116 kt (214 km/h). Malfunctions noted during this initial test period proved minor save for a pair of nagging problems. "Areas of concern, as determined from the flying to date, include horizontal stabiliser buffet which has been encountered with flaps down," a North American Development Bulletin noted. "... Low lateral control effectiveness at moderate deflections has [also] been experienced in the landing approach."

By early October, the first prototype A3J-1 had completed 11 test flights totalling 9 hours and 40 minutes, and had been removed from flight status for installation of the bomb-bay fuel system. The second prototype was scheduled to make its first flight in November. The first evaluation period had demonstrated good directional stability in the aircraft up to Mach 1.4, and wind tunnel testing seemed to indicate that improvements in the flap-hinge area and boundary layer control distribution would correct the buffeting condition encountered at low speeds with flaps down.

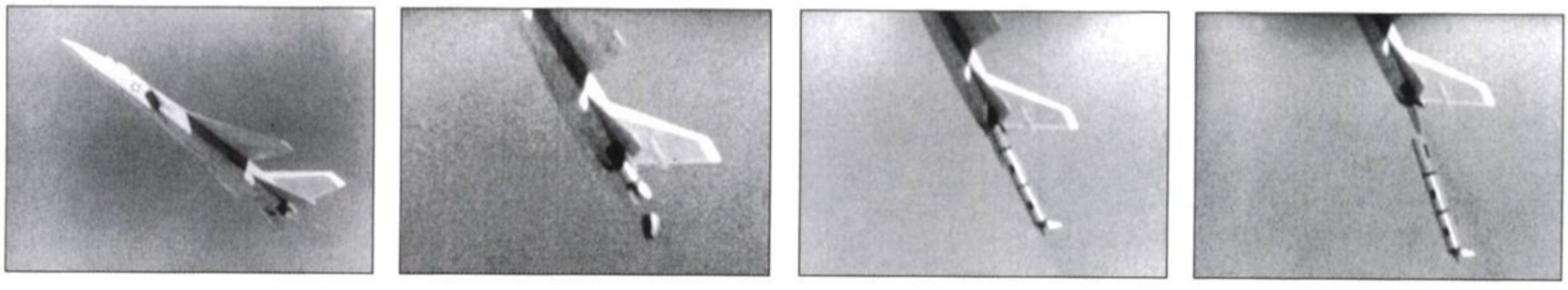
In May 1959, a North American Development Bulletin noted that the Navy had completed its Phase I Preliminary Evaluation of the aircraft after 40 flights in the first two prototypes. Test pilots found carrier-suitability characteristics to be excellent, with "reasonable approach speeds, in the order of 128 kt [236 km/h], good speed control, and satisfactory single-engine characteristics." The report did note that the flights revealed some difficulty in "obtaining secondary airflow and inlet positioning automatically with rather large losses in acceleration performance." However, company officials expressed pleasure in the fact that the aircraft had flown at Mach 2 several times during flight testing and had performed full deflection rolls at Mach 1.7. "No unusual characteristics have been observed, and directional stability, once considered a potential trouble source, appears satisfactory."

Second prototype lost

All told, the two prototypes completed a total of 356 test flights totalling 500 flight hours, the lion's share by BuNo. 145157. The second prototype, BuNo. 145158, crashed on its 49th test flight on 3 June 1959, when hydraulic and electrical systems failure caused the pilot to lose control of the aircraft.

The initial batches of production A3J-1s followed in quick succession and 14 aircraft were employed in test flights by North American and the Navy, evaluating structure, equipment, carrier suitability and bombing. In the ultimate test for any prospective Navy carrier aircraft, which one commentator likened to "the nerve-wracking vigil of a new father", the sixth Vigilante (BuNo. 146697) off the assembly line successfully made 14 launches and arrested landings on the flight deck of USS *Saratoga* (CVA-60) in July 1960. Further tests evaluated spotting and deck handling of the large aircraft, and tested the A3J-1's performance 'around the boat' at higher gross weights and

NAA issued this artist's impression (left) of a linear nuclear weapon deployment. The sequence below, from 16-mm film footage, shows the Vigilante's linear weapon delivery system in action during testing on 4 October 1961. This unique feature never functioned with sufficient reliability and was eventually abandoned.



Trials aboard *'Sara'*

The first successful carrier landings and take-offs by a Vigilante were made in BuNo. 146697 on 22 July 1960, when carrier suitability trials began aboard the 'Forrestal'-class attack carrier USS *Saratoga* (CVA-60), commissioned in 1956. The delivery of production aircraft was still over a year away and this milestone marked just the beginning of a lengthy training and familiarisation period. As well as being a particularly large aircraft for carrier operations, the A3J-1, without the blown flaps fitted to later variants, had a high approach speed and was thus a tricky machine to land on a 'flat top'. The problems this presented to crews were compounded by the fact that fleet A3J pilots had been drawn from the patrol squadron community and were therefore marginally, if at all, qualified to handle an aircraft with such critical landing characteristics as the Vigilante.

Above: In calm seas and sunny weather deck crewmen look on as BuNo. 146697 is catapulted from the starboard bow 'cat' during trials. A pair of CVW-3's F8Us has been spotted on the port side.

Top and right: Deck crew inspect the new shape on their carrier. The aircraft's wingtips and radome have been folded to allow carriage on the carrier's elevators.

varied wind conditions over the deck. In total, as was the case with most new aircraft, intensive flight testing revealed a host of small problems that were corrected by relatively minor modifications in the design.

Flight test tales

Captain Robert Elder, a decorated World War II dive-bomber pilot who in 1958-1959 served as Director of the Flight Test Division at the Naval Air Test Center in Patuxent River, Maryland, was one of the first naval aviators to fly the Vigilante. Among the more memorable flights was his first take-off in BuNo. 145157 on 12 February 1959. In an aircraft seemingly built around a host of new technologies, the A3J-1 incorporated a primitive fly-by-wire flight control system in which stick movements produced an electrical signal that fed into actuators that controlled lateral and longitudinal movement. The master actuators then mechanically positioned the control valves, horizontal stabiliser and spoiler actuators. As Elder thundered into the sky over Palmdale, California, the electrical system failed at an altitude of 200 ft (60 m), and the mechanical back-up immediately kicked in as advertised. "During reversion to manual," Elder recalled years later, "a full nose-down pitch command was pulsed to the horizontal stabilator and the ensuing recovery was best described as a steeplechase through the sagebrush, chasing jackrabbits and trailing a dense plume of dust for several miles across the desert. Fortunately, no harm, no foul, but hardly a confidence builder."

A few months later, the Vigilante provided Elder with another portentous moment, though this time in a more public setting – the May 1959 annual open house at Andrews Air Force Base in Maryland. The initial intention was to place the Vigilante on static display only, but Elder was anxious to show off the Navy's hot new aircraft in the air, particularly in front of a crowd consisting mainly of rival Air Force personnel. During the Vigilante's maiden flight, North American test pilot Dick Wenzel had noted that fire doors had remained open during the entire flight. Elder would have happily traded that problem for the misfortune that beset him as he roared down the runway for a 'burner pass. As he recalled, North American aircraft notoriously had problems with wheel well doors, and on this unfortunate day the one for the starboard main gear snapped off and embedded itself 3 ft (0.91 m) into the stabilator, causing Elder to end his demonstration prematurely and limp the 50 miles (80 km) back to Patuxent River. Luckily, the only casualty of flying parts occurred at the house of an Air Force pilot, who last saw his barbecue fly across the backyard trailing smoke! Needless to say, the next time he grilled out, it was with steaks on a brand new barbecue courtesy of one embarrassed Navy test pilot.

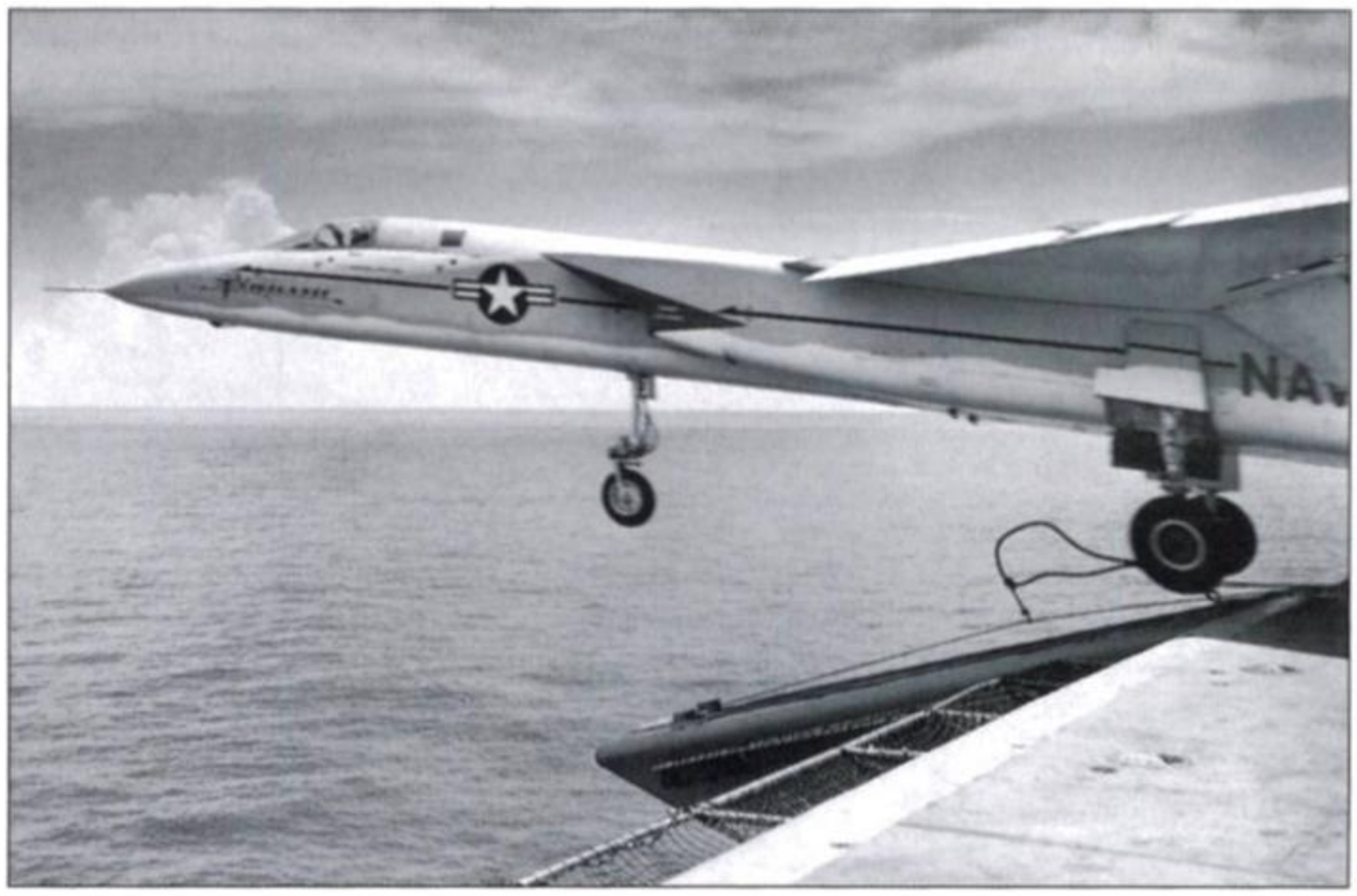
One flight that proved more successful for the Vigilante programme occurred on 13 December 1960. Since the earliest days of aviation, pilots have striven to establish records in everything from speed to altitude, with successful flights placing them in an exalted position within their highly competitive profession. Some of the most famous fliers of all time – Charles Lindbergh, Roscoe Turner and 'Chuck' Yeager, to name a few – achieved their fame flying

Saratoga ***steams into wind (above), as a HUP Retriever 'plane guard' hovers off the starboard beam and deck crew look on while BuNo. 146697 is prepared for another 'cat shot' (inset and below). The Vigilante was unlike anything else in carrierborne aviation in terms of its looks and its size. It was one of the largest aircraft to serve from an aircraft-carrier anywhere – only certain versions of the A3D Skywarrior were heavier.***

farther and faster than anyone before them had. In the years following World War II, chasing records was an almost exclusive domain of the military, with Navy and Air Force pilots seeking to out-perform one another as well as the air forces of other nations, particularly their Cold War nemesis, the Soviet Union. By 1960, North American and Navy officials believed that the A3J-1 had advanced far enough into its test and development programme to take a shot at the existing world's altitude record. With the aircraft's capabilities, they believed that they could easily shatter the 69,000-ft (21031-m) mark then held by a Soviet pilot.

From the ranks of test pilots in the Vigilante programme at the Naval Air Test Center in Patuxent River, Maryland, the Navy selected Commander Leroy Heath to make the record attempt. A combat-proven fighter pilot during World War II, Heath had spent most of his post-war service in heavy attack aviation, including flying AJ Savages and A3D Skywarriors. A 1953 graduate of the prestigious US Naval Test Pilot School, in 1960 he was serving as a project officer on the A3J programme. To achieve the record incorporating the aircraft's normal crew, Heath's fellow project officer, Lieutenant Larry Monroe, was slated to fly in the back seat as the bombardier/navigator.

Since the record-attempt required carrying a simulated bomb load, it was decided to fill the fuel tanks in the aircraft's linear bomb bay with 1000 kg (2,204 lb) of fuel. They were then sealed and disconnected from the aircraft's



A3J-1 production is in full swing in this view of the Vigilante line at NAA's Columbus, Ohio plant in March 1962. These appear to be largely complete airframes, now ready for fitting out with seats, engines and avionics.

fuel system. Working with North American engineers, Heath and Monroe also sought to develop the most favourable manoeuvre for the flight, settling on the zoom climb because achieving the record did not require maintaining altitude in level flight, but simply reaching it for just a moment.

Heath recalls: "Proper execution of the zoom climb manoeuvre requires that the aircraft be eased onto the desired climb angle by a 3*g* pull-up, careful to minimise airspeed loss in the process. Then light forward stick pressure is applied to establish a 0*g* flight arc. At 0*g*, the aircraft effectively weighs nothing and so will not stall. We didn't want the aircraft to stall because if it did it might spin – and the contractor's spin test pilot had already determined that the normal configuration A3J would not come out of a developed spin."

In preparation for the flight, Heath and Monroe put the aircraft through its paces off the East Coast of the United States, attaining speeds of Mach 1.8, pulling into a 35° climb, and achieving 80,000 ft (24384 m). On the third practice run, as the A3J-1 reached that altitude, the aircraft slowly rolled to starboard, and began to literally tumble through the air. Heath manoeuvred the stick repeatedly, but, in the thin air at altitude, there was insufficient resisting force to cause the aircraft to respond. After centring the flight controls and reducing engine power, Heath simply rode the aircraft down, discovering that when it reached the thicker air at lower altitude, it stabilised itself in a vertical supersonic dive. He had learned a valuable lesson.

In December 1960, Heath and Monroe began their run for the record in the skies over Palmdale, California. During the first two runs, they reached 85,000 ft (25908 m), more than good enough to beat the existing record, but in their minds far short of the Vigilante's capability. By increasing the angle of climb and bleeding the airspeed down to zero, the pair believed they could climb much higher. Armed with the knowledge gained in their third practice flight, they were not worried about having to recover from a stall.

The morning of 13 December dawned bright and clear, with an unexpected benefit of the air being 6°F (14.4°C) cooler at the pull-up altitude. This meant that the engines would develop extra thrust and push the Vigilante through the air faster. Though North American engineers did not want the aircraft to exceed Mach 2.1 for fear that destructive heat would build up on its leading edges, nothing could hold it back that day. "It turned out that the aircraft really wanted to go," Heath remembered. "The cruise climb was initiated, and when we reached the pull-up point the aircraft was at 53,000 ft [16154 m] and indicating Mach 2.11." With the voice of the radar operator in their headphones calling out altitude in 5,000-ft (1524-m) intervals, Heath and Monroe rocketed skyward, "whooping like a couple of kids" when the Vigilante reached 91,000 ft (27737 m) and started to nose over.

'Fresh out of the box' this immaculate, though unidentified, production A3J-1 awaits delivery to the Navy and its first assignment.

Into service with VAH-3

The Vigilante entered service as the Navy was implementing a major revision of crew training, establishing Replacement Air Group (RAG) units to support the 'communities' established around the various aircraft types flown by the service. Had the A3J-1 entered wider service with the Heavy Attack Squadrons, both the heavy attack RAGs (VAH-3 for the Atlantic fleet and VAH-123 for the Pacific fleet) would have received Vigilantes, but with the planned switch to a reconnaissance role for the type only one RAG was established for the entire Vigilante force – VAH-3 at NAS Sanford – to provide air and ground crews for Heavy Attack Wing One (HATWINGONE). VAH-3 shouldered the burden of training all Vigilante ground and air crews throughout the type's career, though this situation was eased by the fact that Vigilante complements within Carrier Air Wings were cut from 12 to six with the change in role.

The ride down proved almost more eventful than the climb as the aircraft nosed over and down and rolled over onto its back. With its passengers hanging from their seatbelts, it fell off in a series of rapid half-rolls in each direction before settling into a nose-down dive as it passed through 42,000 ft (12801 m). Relighting the Vigilante's engines, which had flamed out during the zoom climb, Heath brought it in for a landing at Palmdale amidst jubilant Navy and North American personnel. The aircraft's official mark, and new world record, was 27874.203 m (91,450.8 ft).

A bump in the road

While the Vigilante proved itself to be a tremendous flying platform, testing on its unique weapons delivery system did not produce similar results. During 1961-1962, a series of evaluations was conducted by North American and the Navy at the Naval Weapons Evaluation Facility (NWEF) at Kirtland Air Force Base, New Mexico, and at Patuxent River. The aircraft was to be a capable bombing platform in level flight, scoring nine of a possible 12 hits during one flight, but minor airframe deficiencies and persistent malfunctions in its radar and television guidance system affected its performance in the loft bombing and over-the-shoulder delivery manoeuvre.

The most discouraging revelations came during the Initial Trials Phase (ITP) of the aircraft's Service Acceptance Trials at Kirtland during June-December 1962. Pilots and bombardier navigators from VX-5 in the cockpit of a fleet-configured A-5A (the new designation of the aircraft as of August 1962) conducted test drops using 30 different weapons packages and manoeuvres. All told, the aircraft made 136 flights totalling 183.1 flight hours, ending on 31 December 1962.

The results of the ITP proved damning for the Vigilante. On most of the test flights, the aircraft performed capably, proving itself to be an excellent bomb platform, especially when releasing ordnance from conventional underwing pylons. However, the linear bomb bay release method, the foundation upon which the entire aircraft had been designed and constructed, was not reliable. In addition to the persistent radar and navigation difficulties, the actual mechanics of ejecting the weapon from the aircraft proved frustrating. Among the malfunctions encountered were faulty electrical connections, an unreliable ejection gun, and poor separation and post-ejection stability of the store train consisting of the weapon and empty fuel tanks. Such were the difficulties encountered that the linear bomb bay would never be used aboard the aircraft in fleet service.

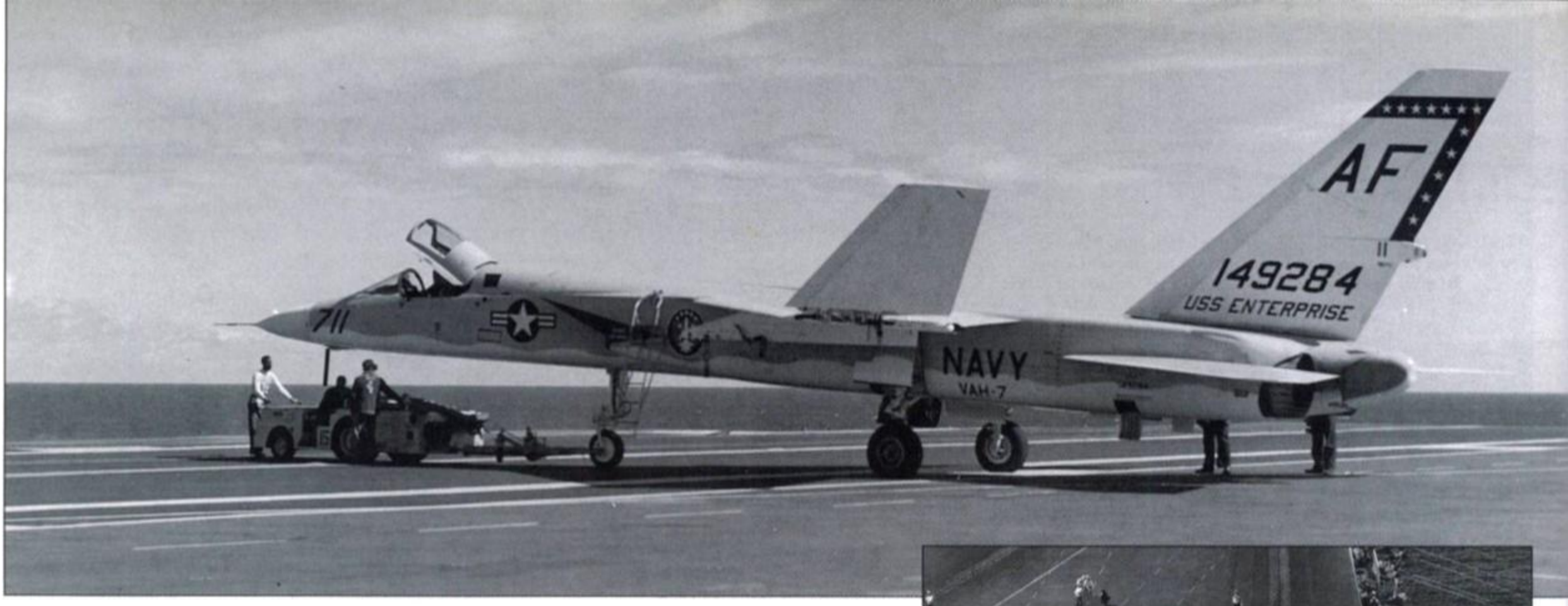
Despite the difficulties experienced with the linear bomb bay, the first A3J-1s joined the fleet and were assigned to VAH-3 at NAS Sanford, Florida, the home of all East Coast heavy attack squadrons. On 16 June 1961 a quartet of factory-fresh Vigilantes led by Captain F. G. Edwards, Commander, Heavy Attack Wing One, roared over the flight line at Sanford, symbolising the beginning of a changing of the guard in the heavy attack programme.

Given the complexity of the new aircraft, the Fleet Introduction Program (FIP) for the A3J required extensive support from North American Aviation, which sent 35 technical representatives to Sanford to assist in introducing the Vigilante to pilots, bombardier/navigators, and ground support personnel. An old hangar once assigned to support a Fleet Air Service Squadron (FASRON) was converted into a veritable college to study every facet of the A3J. Each of the 21 classrooms in the building was devoted to instruction in a particular system, and featured a complete operating mock-up of that system, be it flight controls, powerplant, electronics or armament. For example, those students who would be tasked with maintaining the aircraft's intricate fuel system could watch the actual operation of various pumps, valves and gauges by observing a functioning cutaway of the equipment that substituted pink hydraulic fluid in place of actual fuel. All told, 170 men enrolled in the first A3J maintenance course, including personnel from VAH-3, VAH-7, and the Overhaul and Repair Facility at NAS Jacksonville, Florida, which would be involved with the progressive aircraft rework programme for the Vigilante.

Above: One of VAH-3's A3J-1s traps successfully aboard USS Franklin D. Roosevelt (CVA-42) on a 1 August 1961 training flight, its main gear lifting off the deck as it is brought to a halt.

Top: Led by BuNo. 147860 (left), the first four A3J-1s for a USN squadron prepare to leave Columbus for VAH-3 at NAS Sanford on 16 June 1961.

Below: BuNo. 148930 is manoeuvred on the deck of an unknown carrier sometime between late 1961 and September 1963, when the aircraft was lost in an accident.

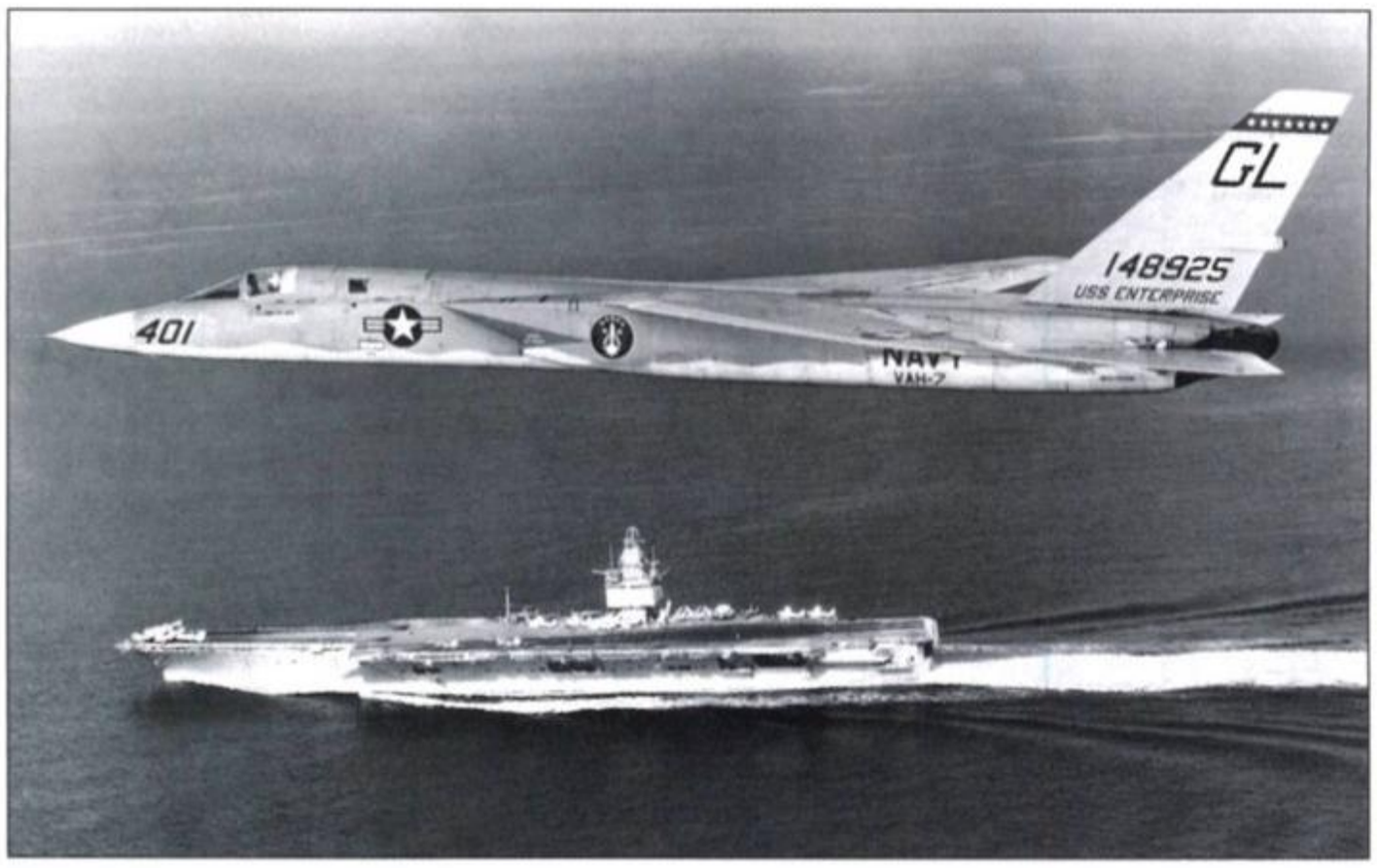


HATRON 7 joins *Enterprise*

Activity aboard Enterprise *during its first cruise, including that involving Heavy Seven's Vigilantes, was captured for posterity by Navy photographers. Carrier Air Group Six also debuted the F4H-1 Phantom (VF-102) in the Sixth Fleet on this cruise.*

The Vigilante's operational debut came in August 1962 when VAH-7 took 12 A3J-1s to join CVG-6 in USS *Enterprise* (CVAN-65) for a short cruise with the Sixth Fleet in the Mediterranean. After two months at sea, the carrier returned to the US in October, the squadron spending Christmas and the New Year in Florida in the aftermath of the Cuban Missile Crisis. In early February 1963 VAH-7 returned to the 'Med', this time on a full-length cruise lasting seven months.

When VAH-7's aircraft joined* Entreprise *they were carrying 'GL' shore tail codes and '4xx' Modex numbers. Here BuNo. 148925 '401/GL' is seen over the 'Big E'.



Pilots and bombardier-navigators spent countless hours in the weapons system trainer (WST), which was built under contract by the Link Division of General Precision, Inc., builder of the famed Link Trainer of World War II. Housed in three trailers, the WST could simulate every element of a combat mission, from take-off through various modes of attack to landing. It could also throw in the unexpected, be it instrument flying conditions or a simulated ejection sequence. Controlled by a complex analog computer, the WST could train pilots and bombardier-navigators separately or as a crew. The standard curriculum called for pilots to spend 105½ hours in classroom and simulator work, while bombardier/navigators received 134½ hours of instruction outside of the cockpit.

Before even climbing into the Vigilante, prospective crews received instruction in other aircraft, with pilots spending six hours in the cockpit of an F9F-8T Cougar two-seat trainer and bombardier/navigators making some 20 flights in propeller-driven R4D Skytrains and jet-powered A3D-2T Skywarriors, practising navigation and bombing techniques. Training flights in the A3J-1 consisted of aerobatics, night familiarisation, and a host of attack missions involving high-altitude, loft and over-the-shoulder bomb delivery methods. After a pilot or bombardier/navigator qualified in the aircraft, the training intensified within the competitive heavy attack community. Delivering a nuclear weapon was serious business and the crews wanted to be ready in the event of 'the call'. To this end, throughout the year squadrons and crews competed against one another in monthly 'bomber streams', striving to achieve the highest scores for both bombing accuracy and navigation. The best were recognised on 'totem poles' erected in a prominent location on the grounds of NAS Sanford. In plain view of everyone, each month these totem poles displayed in descending order the top 10 crews and top seven squadrons, based on their performance. Serving as a motivational tool, a 'bad guys list' containing the names of all those who did not meet minimum training requirements in a particular month was published and distributed among the squadrons. It all culminated in a week-long annual

Programme costs
Of potentially greater consequence than the difficulties experienced with the Vigilante's linear bomb bay, the escalating cost of the programme began to cause concern as the A3J-1 entered production. By the standards of the day the Vigilante was a complex aircraft and this, plus the aircraft's performance, had not come cheaply. Millions in research dollars had been spent ($177.9 million in FY1962 and over $200 million in FY1963) and as unit costs rose towards $10 million, Congress began to ask questions of the Navy. Other programmes, notably the A2F Intruder (A-6 from 1962), were moving ahead on time, on schedule and on price and offered comparable accuracy in their weapons delivery (albeit with much greater vulnerability thanks to its relative speed).

Engines and engine bays
Initial production A-5As were equipped with a pair of J79-GE-2 turbojets producing 15,150 lb (67.39 kN) of thrust with afterburner at sea level. Soon after production began, however, the GE-4 variant was introduced, this bringing a maximum thrust increase (to 16,500 lb/73.4 kN). The similarly-rated J79-GE-8 followed, this variant equipping most A-5As, all A-5Bs and the original batches of new-build RA-5Cs. The primary structural material used in the Vigilante's engine bay was some 2,400 lb (1089 kg) of titanium. Also worthy of note was the fact that the inner surfaces of the engine bays were coated with a heat reflecting spray-on gold film which was baked in place.

North American A-5A Vigilante
Heavy Attack Squadron 7 (VAH-7)
Carrier Air Group 6 (CVG-6)
USS *Enterprise* (CVAN-65)
Mediterranean, 1962

BuNo. 149283 was one of the last A-5As built and is depicted as it appeared during HATRON 7's first cruise aboard USS *Enterprise* (CVAN-65) in 1962. Standard Gull Gray/Insignia White colours and markings for the period were used, with the exception of the stylised '7' on the fin in Insignia Blue, behind 13 white stars.

Unenviable reputation
The Vigilante always had a reputation for being a tricky aircraft to handle around a carrier, pilot inexperience coupled with the A-5A's high approach speed leading to a number of ramp strikes and the loss of several aircraft and crews. Though the A-5B was to benefit from blown leading-edge flaps (in place of blown trailing-edge surfaces in the A-5A) and thus improved handling, the 'Vigi' had gained a reputation that stuck.

Rear cockpit visibility
Though the Vigilante's pilot had a fairly good field of view, the same could not be said of the bombardier/navigator (B/N) – though it was better than it might have been had earlier plans come to fruition. In mock-up form the A3J-1's rear cockpit was covered by a fully transparent canopy. However, as a completely blacked-out cockpit offered the best environment in which to view a radar display and offered better protection from a nuclear blast, it was proposed to fit a solid rear canopy instead. Prospective B/Ns were unimpressed, citing the likely onset of claustrophobia as their main objection and before long a compromise was arrived at whereby a small glazed panel was provided either side of the canopy.

AN/ASB-12
North American Autonetics provided the AN/ASB-12 bomb directing set to provide basic navigation and aircraft positioning via various component parts, including a GE Electronics multi-mode radar, North American NASARR radar computer (and associated Pilot's Projected Display Indicator), CCTV (for daytime visual identification), Radar-Equipped Inertial Navigation System (REINS) and a Versatile Digital Analyser (VERDAN, a digital computer sometimes unkindly referred to as the 'Very Effective Replacement for a Dumb Ass Navigator').

A3J/A-5 Vigilante

For air-to-air refuelling a hydraulically-operated IFR probe was fitted in the left forward section of the Vigilante's nose, hinged at the base and folding to the rear when retracted. Using the Navy's standard hose-and-drogue system, fuel could be transferred at a rate of 2,000 lb (907 kg) per minute. Here a VAH-7 A-5A takes fuel from a 'buddy' pod-equipped A4D-2N from VA-66 as another looks on. Both squadrons were aboard* Enterprise *for its 1962 deployment.

Below and bottom: VAH-1 'Smokin' Tigers' made just one carrier deployment with the A-5A – an eight-month stint aboard USS* Independence *from early August 1963. The composition of the carrier's air group caused problems. With single units of F-4s, F-8s and A-5s, plus three of A-4s and no dedicated tankers, the limited IFR capability of the A-4s and A-5s was called upon more than once to refuel aircraft that would otherwise have been lost.

Bombing Derby pitting the four top crews from each unit against one another.

Chief Aviation Structural Mechanic Colin Pemberton, who began flying heavy attack missions in the propeller-driven AJ Savage, served as an enlisted bombardier/navigator during the early days of the Vigilante programme. After graduating in the first class of pilots and bombardier/navigators to complete indoctrination in the Vigilante, he became an instructor in training crews for the new aircraft.

"We taught high-altitude and low-altitude navigation and with the Vigilante we had the inertial navigation. We used to update that with our radar – put in the co-ordinates where we wanted to start and where we wanted to go, and put in our checkpoints and update our radar [that way]. We started out in FAM [familiarisation] hops. We would team up a navigator and a pilot coming through and they would stay together the whole time. They would plan their navigational flight[s] and they would have to compute the bomb releases in case the system didn't work [and] you had to release manually.

"When we first got them [Vigilantes] and I was setting up the training, we didn't have any bombing equipment in the aircraft. We used to use a LABS 18 and it was set for a loft manoeuvre. We'd teach them the loft manoeuvre. In the loft manoeuvre you come in at about 100 ft [30 m] and 600 kt [1106 km/h]. We'd go down to Lake George and [the pilot] would pull that thing up and it would pitch the bomb out at 51°. That sucker would go up to 20,000 ft [6096 m] and come back down. So they'd compute all that and they had to work that out manually – the winds at altitude and how they were going to affect it [the weapon]. At first all this was manual – pencils, paper, computer, calculators and stuff. And we always had radar scope photography and we could see if they were finding the right targets.

"A lot of training was done with what we call radar bomb scoring. We would have [radar] sites at Jacksonville, Charleston and Atlanta. And we would have the bridge at Jacksonville, and the prison at Atlanta, [a total of] six or seven targets at different places. The radar site would pick you up and track you in and you would give a [signal] when you had released a bomb. You'd give them your altitude and air speed and they'd compute it with the ballistics of that particular weapon and where you released, and you would get your score. In a bombing competition, you would launch, at night always, hit Jacksonville, run up to Charlotte, hit it, and come back through Atlanta. Other times we'd go out as far as Kansas City. The Air Force had more [radar] sites than we did so we had to make special arrangements and that sort of changed the pattern. We'd see these [the Navy] targets every day so it really wasn't fair, so we'd go up and hit some of the Air Force sites out west and maybe pick up one or two on the way back.

"They [the bombardier/navigators] would have to plan their flights [using] strip charts. They'd put what they were going to use for their radar checkpoints. For low-level flights they had these tic marks every minute – every 7 miles [11 km] – so they knew exactly where they were. Of course in the Vigilante you didn't have much room, just that little window, so you couldn't do any visual navigation as such unless everything else quit. You were really busy the whole time. We had a television set [and] a radar set. We had optics and of course the inertial nav[igation]. As long as that was working it was great, but we used to have a lot of trouble maintaining it.

"For bombing, most of the time they had Mk 86 practice bombs, which were actually beer can-type things. So a lot of our bombing was low altitude, either the loft bombing or the 500-ft pop-up type. You'd climb up to 5,000-ft [1524 m] and then drop it. We did some of that in Lake George [and at] Key West. Each wing pod held eight bombs and they were really heavy, must have weighed 40 or 50 lb [18 or 23 kg] apiece. So we would open the container and

we'd go up and release one and come back and release another. Coming in there over Lake George we'd pick a visual IP (Initial Point) and [the bombardier/navigator would] say, 'You're over it', and from that point we'd have to time our pull up and so we'd tell the pilot, 'Okay, pull up now.' He'd pitch it up and it was pretty much automatic after that – pitch it up, fly it out, and then get a wing over and get the hell out of there to practise getting away from the nuclear blast. It was a blast. It was a lot of fun.

"For the graduation flight down there in the RAG [Replacement Air Group], we had pressure suits for high-altitude flying above 50,000 ft [15240 m]. We would take off and run up to Charleston and get up to about 60,000-64,000 ft [18288-19507 m] and head down from Charleston over water to Daytona. And at that point we'd get up to Mach 2 and check in with ground control at Jacksonville. And they would monitor us and give us our ground speed. By the time we got to Daytona, of course, we didn't have any extra fuel tanks and we had to land because we were just about out of gas. There was no sensation going Mach 1 or Mach 2. You're just there and you look at your instruments."

Pilots being pilots, there was some extracurricular activity during training flights at Sanford, particularly in an aircraft with the speed of the Vigilante. During one night flight along the east coast of Florida, a pilot decided to impress a friend, who at the time was serving as the mayor of a city along the coast. Igniting the afterburner and dumping fuel simultaneously, he created a stream of fire behind his aircraft as he flew over the Atlantic. The authorities were none too pleased when his wheels touched down at Sanford!

Punching out

On 17 March 1961, Lieutenant Commander Grimes ejected from the ninth A-5A (BuNo. 146700) during a test flight over Patuxent River. Maryland, thus becoming the first Navy pilot forced to bail out of a Vigilante. He would not be the last. All told, during the A-5/RA-5C's relatively short lifespan, 37 crews ejected from their aircraft because of operational difficulties alone, to say nothing of those forced to eject because their aircraft were hit by enemy fire over North Vietnam. Given the operational parameters of the Vigilante, particularly its Mach 2 speed and high-altitude capability, the designers at North American realised the need to develop a capable ejection system for the crew, and work on one paralleled the development of the aircraft itself.

Development of the A3J-1 escape system, which would officially be called the HS-1/1A, began in 1956, and engineers sought to design a system that required a minimum expenditure of effort by the aircrew. The result was a system in which the pilot initiated ejection for both crewmen; the backseater could eject alone in the event the pilot was incapacitated. This was done either by pulling a face curtain or a handgrip on the left underside of the seat. At that juncture, after only 0.2 seconds, the seat automatically positioned the crewman's torso and extremities into position for the ejection, a reel pulling his shoulders tightly against the seat back and a bar coming up just below his kneecaps and forcing his legs up. Only 0.4 seconds after initiation of the ejection, a catapult-rocket system fired, beginning a sequence in which both aircraft canopies cleared the cockpit area and the aircrew blasted upward and out of the aircraft. Peak acceleration ranged from 10*g* to 13*g*, and total time for the catapult acceleration was 0.16 seconds

Just 0.02 seconds after the seat detached from the rocket rails, a drogue shoot deployed to stabilise it, and once that occurred the foot retractors, harness and lower drogue parachute risers released. At 13,000 ft (3962 m) altitude or below, this sequence occurred approximately 1.76 seconds

Above: VAH-7's second and third carrier deployments (in 1963 and 1964) took the squadron back to the Mediterranean. With 12 aircraft in a VAH squadron, the A-5's size presented space problems, even aboard* Enterprise*, the newest and largest carrier in the US fleet.

Top: One of VAH-7's A-5As races along the deck of* Enterprise *as it is launched from the starboard 'cat', probably in the Mediterranean in 1963 or 1964.

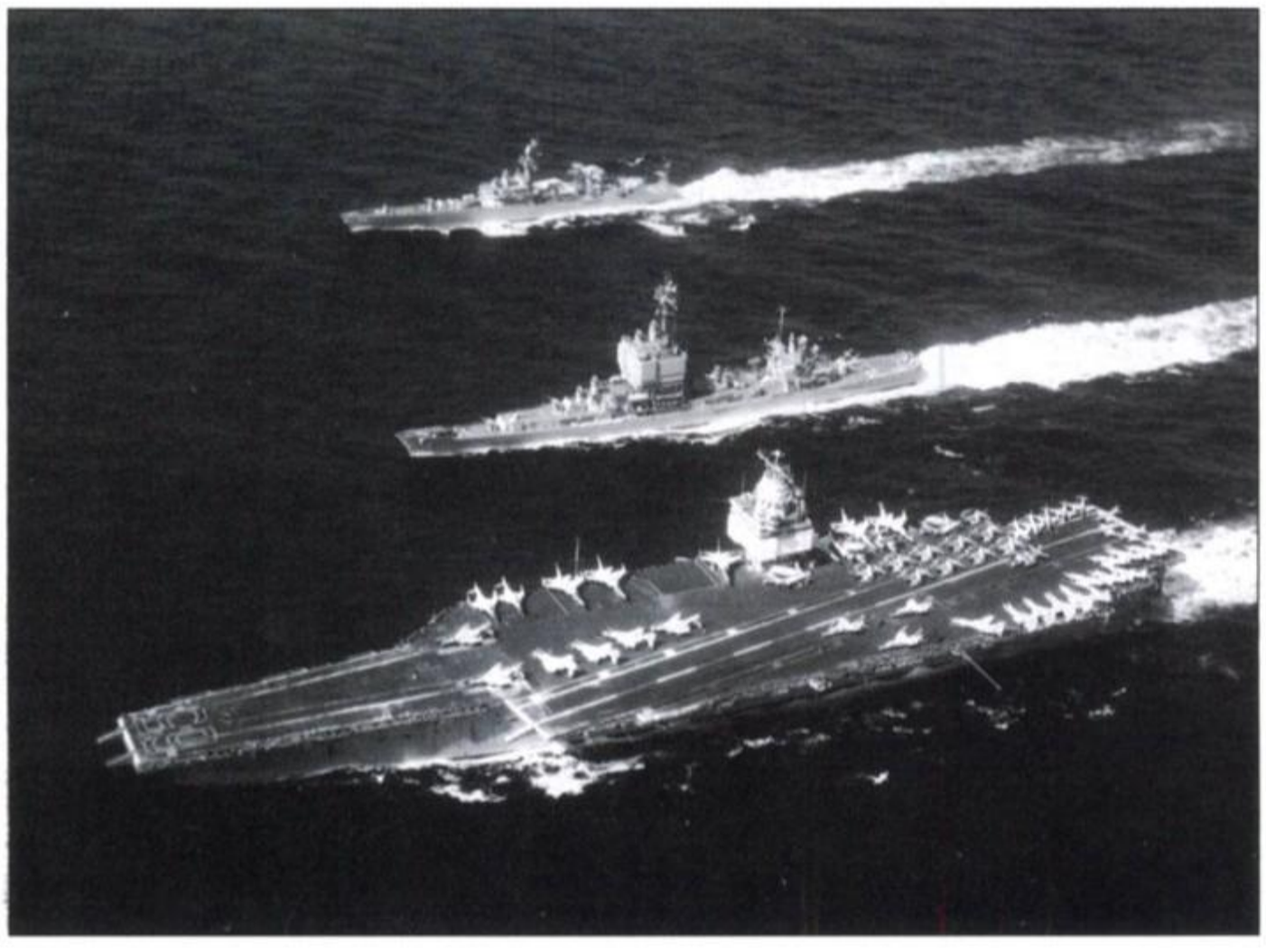
CVG-6's 'CAG bird', 'AE/700', (note the multi-coloured stars on its rudder) leads a trio of VAH-7 aircraft over NAS Sanford.

after the initiation of the ejection, and for those ejecting at higher altitudes, the drogue shoot did not deploy until the seat reached 13,000 ft. Simultaneously, air bladders located on the seat inflated, boosting the occupant from the seat. The drogue parachute separated from the seat as well, deploying the crewman's chute before falling away. Thus, after only 3.01 seconds the Vigilante crewmen found themselves out of their stricken aircraft and floating toward Earth beneath a billowing parachute. Making the system more impressive was its successful functioning anywhere from 90 per cent take-off speed at ground level throughout the entire operational spectrum of the Vigilante.

Over the course of the operational career of the Vigilante, the HS-1/1A was put to the test in a variety of situations, and generally met with great success. An examination of a North American Aviation case study of actual ejections conducted during the late 1960s reveals the inherent flexibility of the escape system. On 5 May 1964, Lieutenant Commander J. E. Chapdelaine and AE1 C. Stringer were in a 70° vertical dive at 2,500 ft (762 m) altitude when they ejected without injury. At the opposite end of the spectrum, an RVAH-5 crew was attempting to recover onboard USS *America* (CVA-66) when the main landing gear failed and their Vigilante went skidding down the flight deck with its left wing down. Ejecting at just over 100 kt (184 km/h) airspeed and zero altitude, the officers were safely recovered.

Perhaps no two men owed more to the HS-1 than Lieutenant Commander W. E. Pippin and Lieutenant (junior grade) P. S. Otis, another RVAH-5 crew operating from USS *America*. On 3 September 1965 their Vigilante hit the ramp during an approach for recovery and slid across the carrier deck. Both men ejected safely. Less than six weeks later, Pippin and Otis were at it again: this time they collided with an F-4B Phantom II at an altitude of 800 ft (244 m) while both aircraft were in the landing pattern. Again, both officers managed to egress the aircraft with another story to tell their grandchildren.

Five Vigilantes share the deck of* Enterprise *(CVAN-65) as it cruises with guided-missile destroyer USS* Bainbridge *(DLGN-25, top) and the cruiser USS* Long Beach *(CGN-9) during Operation Sea Orbit.



Coming aboard

"An A-5A ran into the ramp and exploded, spreading fire from one end of the deck to the other. That is a Mach 2 aircraft and big, and is a real demanding one to bring aboard a carrier. One must never be low over the ramp, though the deck looks small. There is something we don't understand about this aircraft and the ramp strikes. It must be a combination of sink rate, angle of attack, and power settings." This was the characterisation of the Vigilante's performance aboard USS *Enterprise* (CVA(N)-65), penned in his diary by Rear Admiral John T. Hayward, Commander Task Force 60 aboard the ship.

Sea Orbit – the A-5's swansong

At the conclusion of its 1964 cruise with the 6th Fleet in the Mediterranean, USS *Enterprise* (CVAN-65), with VAH-7 aboard, joined Task Force 1 with guided-missile destroyer USS *Bainbridge* (DLGN-25) and cruiser USS *Long Beach* (CGN-9) for Operation Sea Orbit – a circumnavigation of the globe intended to prove the ability of the Navy to conduct prolonged operations anywhere in the world and provide a showcase for the Navy's new generation of nuclear-powered warships and the nuclear weaponry with which they were armed (including that carried by the A-5). When the task force docked at Norfolk, Virginia on 3 October 1964 after seven months at sea, the A-5A's carrier service was at an end. The first generation Vigilante, complex and maintenance-intensive and without a functioning weapons delivery system, had not been an unqualified success. With RA-5C deliveries having begun in January 1964, the A-5As were removed from the heavy attack inventory, relegated to a training role, and eventually returned (in most cases) to NAA for conversion to RA-5C standard.

Though never officially tasked with providing a 'tanking' facility, the A-5A could be equipped with a hose-and-drogue in-flight refuelling capability utilising a 'buddy' tank system housed in the linear weapons bay. Operated by the B/N via a control panel in his cockpit, the complete, non-jettisonable system consisted of a 290-US gal (1098-litre) buddy tank, two bomb bay fuel cans, a pump unit and 78 ft (23.8 m) of hose. VAH-7 and VAH-1 both appear to have trialled the system during their carrier deployments; here an F-8 Crusader takes fuel from a VAH-7 Vigilante.

Left: Its IFR probe deployed, a Vigilante approaches another to refuel. When the 'buddy' system was installed the tailcone usually fitted at the extreme rear of the linear bay was omitted.

Landing an aircraft on the pitching and rolling deck of an aircraft-carrier, particularly at night, is never an easy task. However, during its operational career the Vigilante received a reputation for being a particularly difficult aircraft around the boat.

"It took a major effort to convince pilots that it was an aircraft much like any other," recalled 'Boom' Powell, who served as a landing signal officer in the reconnaissance RAG. "Elementary psychology was part of the reason the reputation endured. When you encountered the 'wow, you land Vigis on the ship, you must be special' attitude, what were you going to say? 'No, it's easy'?"

Bringing the 'Vigi aboard'

Coupled with this mental factor were some tangible ones that contributed to operational difficulties when it came to planting the aircraft on the flight deck.

"I used to envy the hell out of those A-4 pilots just bringing their little planes aboard. It took a better pilot to fly the A3J than some of the smaller aircraft." This statement from one squadron skipper reflects one of the obvious factors when it came to operating the Vigilante aboard ship – the aircraft's size. And in landing the aircraft, the size translated into a higher landing speed, which in turn meant that if an approach was not precise and corrections to the flight attitude were not executed in a timely manner, the resulting bounce could result in serious damage to the aircraft.

"The A3J came aboard fast, at 145-150 kt [267-276 km/h], and needed to be set up properly 'in the box' early," remembered former Vigilante driver H. J. Bakke. "Late corrections were tough to make and a poor landing attitude was unforgiving in that it resulted in a leap back into the air upon engagement and a blown nose tyre upon recontacting the deck. Then, usually the two J79s would gobble up the tire fragments."

In fact, it could be said that the entire design of the nose wheel in the A-5s was weak, for after repeated landings the bearing races began to crack. In some cases, the entire wheel fractured at the axle after a hard bounce, which was certainly more serious than a blown tyre. Later Vigilantes featured a beefed-up nose gear that remedied this deficiency.

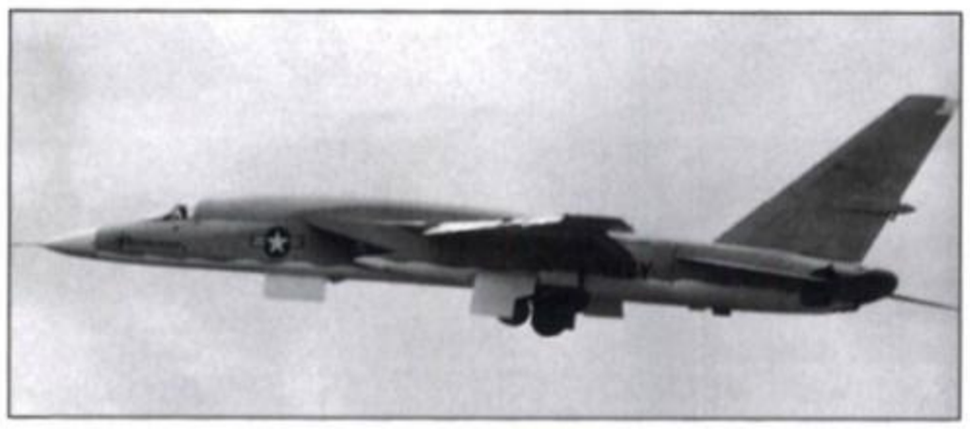
In addition to this nose wheel difficulty, the aft part of the aircraft was susceptible to even a slight adjustment to the aircraft when landing. As 'Boom' Powell recalled, "The accident rate did stay relatively high because of the 742 bulkhead. This single piece had holes for the burners and fuel can, plus the stabilators, vertical fin and tailhook bumper were fastened to it. It was a high stress area and a tweak of the nose at touchdown or a plain bad bounce would crack it. The whole back end [of the aircraft] had to be taken apart to repair it and the [repair] hours drove what should have been a minor problem into the Class A mishap category."

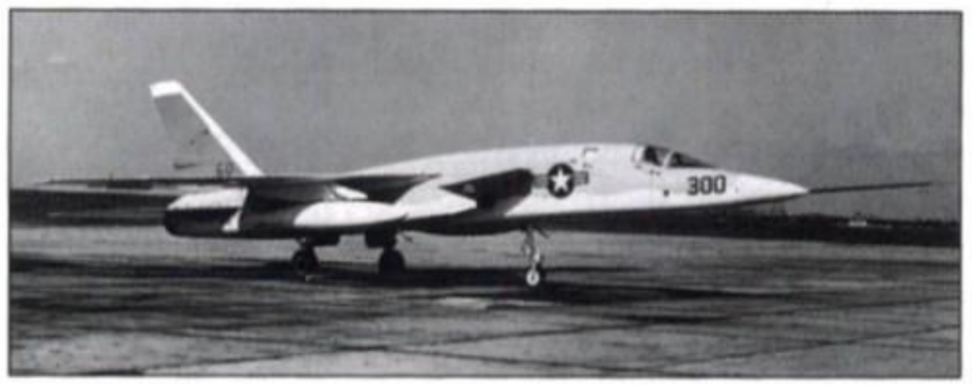
Another structural area of concern was the cockpit, which in effect was bolted to the fuselage by barrel nuts at the forward portion of the wing. After one flight, Captain Ken Enney noticed wrinkles had developed on the aircraft's skin along the fuselage around this area. Repeated landings had contributed to the barrel nuts cracking, which in a worst case scenario could have meant the entire cockpit

This remarkable photograph shows BuNos 147853, 148924 and 147854 of HATRON 7 demonstrating their IFR capability during the 1963 or 1964 cruise aboard **Enterprise.**

A3J-2 (A-5B)

Just as North American began to promote the A3J-2 to the Navy, the Joint Chiefs of Staff came to the decision that the Navy's future contribution to the maintenance of the American strategic nuclear deterrent should be confined to ballistic missile-equipped submarines. The carrierborne heavy nuclear bomber was dead and the Navy and North American were left with an excellent airframe without a role. In order to keep the programme alive, the manufacturer and its customer joined forces to promote the Vigilante to Congress as a low-level conventional attack aircraft. Soon afterwards NAA presented a number of proposals to the Navy intended to address the shortcomings of the A3J-1 while also improving internal fuel capacity and the Vigilante's ability to carry payloads externally. To facilitate these performance gains the Navy relaxed its requirement that the aircraft be able to take-off from a carrier with zero wind-over-deck – a stipulation largely responsible for the Vigilante's aerodynamic complexity and handling characteristics.





Above: As finally built, the A3J-2 was powered by the improved J79-GE-8 that powered late-production A3J-1s, and incorporated important airframe changes. The addition of blown leading-edge flaps (the augmented trailing-edge flaps being deleted) and an increase in the span and chord (and thus, area) of the trailing-edge flaps allowed a 60 per cent increase in gross take-off weight to 80,000 lb (36287 kg), while the so-called 'top cap' modification increased fuel capacity.

Top right: The first production A-5A, BuNo. 146694, was the first Vigilante modified with the distinctive hump-backed 'top cap' fuselage, though windows for the RAN were omitted. On 9 January 1963 the aircraft was lost after its pilot ejected during a flight from Columbus.

Above right: BuNo. 149300 was the first A-5B and one of only two (with BuNo. 149302) to be delivered to the Navy. The '60' on the tail was the aircraft's factory number.

In this view of BuNo. 146699, converted from A-5A to A-5B standard (and later as an RA-5C aerodynamic prototype), the ducting for the blown leading-edge flaps may be discerned under the wing root. This was repositioned above the wing in the RA-5C.

section falling off the aircraft during flight.

Certain design features of the Vigilante also affected its performance in carrier landings. The Pitch Augmentation (PA) System was built in to supplement the adjustment of the flight control system by the pilot. At the relatively low speeds encountered in landing the aircraft, the PA "provided positive horizontal stabiliser position response to control stick movements". Unfortunately, on the early A-5 cruises just after the aircraft's introduction, the PA often did not work, and pilots discovered that it required a lot of wrestling with the stick to put the aircraft on the proper glide slope. And without the benefit of PA, pilots on one carrier discovered that each squadron bird possessed individual quirks when coming aboard.

Bakke recalled one particular aircraft, Number 702, during his time with VAH-7 in *Enterprise* during 1962-1963. "One of our birds would not trim up on the [glide] slope when flying without pitch aug. You'd trim it full nose-up, but still have to hold back stick for stable operations on the slope. The condition was not a downing squawk; you just had to remember it when flying 702!"

A sidelight to this problem was that when 'calling the ball' on carrier approach, VAH-7 pilots sometimes announced to the LSOs over the radio whether the pitch augmentation system was engaged. As a jab at their jet-jockey comrades, a few pilots from the A-1 Skyraider squadron aboard the ship took to saying "no pitch aug" during their approaches as well.

Boundary Layer Control

The Vigilante also featured a Boundary Layer Control (BLC) System, which was automatically co-ordinated with the operation of the wing flap. The system, which decreased the airspeed and angle of attack required for approach and landing, directed high-velocity air over the landing flaps when the pilot began lowering them. This effectively increased lift and reduced the angle of attack required for landing. The operation of the BLC required engine operation above approximately 80 per cent, and the aircraft's designers installed a 'friction gate' in the Vigilante's throttle quadrant as a reminder of this requirement. Thus, the pilot had to exert definite pressure on the throttle to breach the gate. If he did this while the Pitch Augmentation System was engaged, "the result was a deterioration of BLC and a dramatic loss of lift, accompanied by a nose drop," recalled one pilot. "Obviously, one did not retard the throttles beyond the friction gates while on the [glide] slope, and more obviously, this almost eliminated the possibility of correcting for a high and/or fast [approach] on close."

Captain Charlie James, USN (Ret), who logged time in both the A-5A and RA-5C, recalled that changes in the BLC between the two aircraft affected their respective carrier landing characteristics.

"The A-5A wasn't all that bad because when you added power in the A-5A it had BLC over the flaps and you'd actually rise like an elevator. It really had a lot of excess power and was pretty nimble. When they turned the A-5A into the RA-5C, they added about 8,000 lb [3630 kg] onto the aircraft. When they changed it, they moved the BLC to the leading edge of the wing rather than the trailing edge. They were robbing a goodly amount of excess power off of the engines to blow that leading-edge BLC. Now when you added power, it would push the nose down. You'd have to come back on the stick at the same time you added the power [and] your nose was coming down. That was a little bit exciting to get used to."

Although he did not remember the aircraft as being difficult to land, a veteran pilot in both the A-5 and RA-5C did recall that it left little margin for error. "I was really not enthralled with the longitudinal system in it," Ken Enney recalled of the Vigilante's Boundary Layer Control System. "It landed in a fairly flat attitude. You didn't have much room for error in that respect." To this end, he and some other pilots preferred to use full manual settings when operating around the boat.

Finally, the wing spoilers and deflectors on the Vigilante provided an added challenge for the carrier pilot. Flight handbooks for both the A-5A and RA-5C versions of the aircraft provided a word of caution about the lateral control of the aircraft being directly proportional to maintaining proper

RA-5C – Vigilante reborn

Briefly known as the A3J-3 (though never officially as the, perhaps more logical, A3J-3P), the RA-5C grew out of the Navy's lack of fleet reconnaissance capability, a situation that gave Secretary of Defense Robert McNamara the reason he needed to keep the Vigilante programme alive. Approved by the tri-service Darrow committee (which considered all reconnaissance systems with a view to integrating the services' various systems platforms and eliminating overlap), the A3J-3 was to be equipped with not only cameras, but also a SLAR and PECM (Elint) equipment. Meanwhile, A3J-2 production had begun, the first prototype flying in April 1962. Eighteen were completed; of the first six examples, two were delivered to the Navy and the remainder converted as YA-5C prototypes, while the other 12 were retained by NAA and eventually converted to RA-5C standard. The first purpose-built RA-5C got airborne on 30 June.

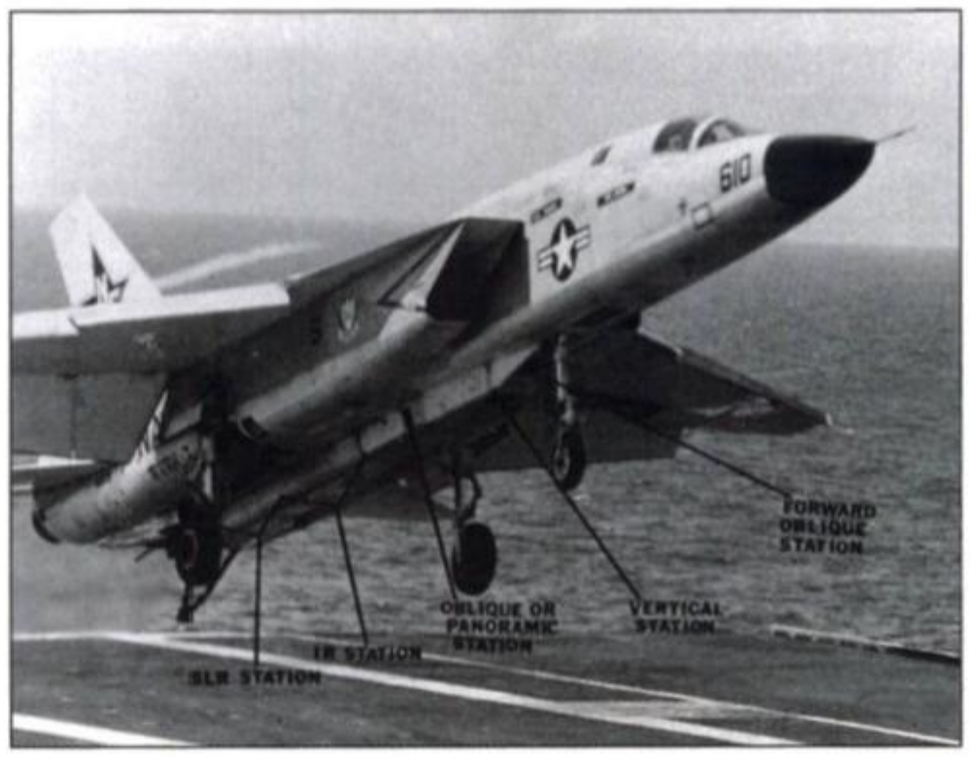
Top: The first RA-5C constructed as such from the outset, BuNo. 150823 is seen outside the Columbus factory, by then the home of the North American Rockwell Corporation.

speed during approach. If the pilot did not maintain adequate speed required by the approach angle of attack, lateral control became marginal. In addition, the larger spoiler deflections resulting from lateral control movements during approach caused a high sink rate, which was amplified by turbulence encountered over the stern of the carrier, known to naval aviators as the ramp. It was a condition that was difficult to detect, particularly at night. "The spoiler/deflector system [was] really a max drag operation," Charlie James concluded. "It was not good for slow speeds."

To one A-5A pilot, the early Vigilante was "the most demanding aircraft in the wing to bring aboard, considering its contemporaries in 1962-1965". However, by the time the later versions of the RA-5C appeared in the fleet, the aircraft's performance around the boat had markedly improved, the result of the installation of auto throttles and leading-edge flaps on the wings, as well as the upgrade to the J79-10 engines.

Yet, in some cases, Mother Nature presented a challenge that disrupted operations. "The test centre had said 'No, we're not going to use 50° flaps due to derogation and wave-off capability.' They wanted 40° flaps," recalled Enney of the operational parameters in the Tonkin Gulf off Vietnam. "Some people did that – some people ignored it, but with 40° flaps on a hot day over there, the true air speed coming aboard was up around 155 kt [285 km/h]. That meant the aircraft had a lot of inertia. My attitude was, the slower you come aboard, the less problem you're going to have getting the aircraft down where you want it."

With personnel progressing steadily through the training programme at Sanford, it was not long before the first Vigilante squadron made ready to go to sea. VAH-7 began flying A3J-1s borrowed from VAH-3 in August 1961, and on 25 January 1962 began receiving the first of its assigned aircraft from Columbus. Established in October 1950 as VC-7, the 'Peacemakers of the Fleet' had operated AJ-2



Above: The factory number 76 stencilled on this aircraft identifies it as BuNo. 149316, the second to last of the 18 A-5Bs constructed. Here it is seen undergoing conversion to RA-5C standard at Columbus.

Left: This view of a late-production RA-5C, at a typically high pitch angle as it touches-down, shows the salient features of the aircraft's sensor package. Also evident are its blown leading-edge flaps, enlarged trailing flaps and the modified intakes and LERXes associated with the installation of J79-GE-10 engines in late-production aircraft.

Left: A-5A BuNo. 146699 served as an RA-5C aerodynamic prototype and is seen here during early trials, with four underwing 400-US gal (1514-litre) drop tanks. These were rarely used in service, as the Vigilante was able to carry a prodigious amount of fuel internally.

BuNo. 150823 cruises with 'everything down' for the camera. The aircraft spent most of its career at Patuxent River, though it had moved to Jacksonville by the time it was finally stricken in June 1976.

Savages and A3D-1/2 Skywarriors prior to receiving the Vigilante. Fittingly, the squadron was scheduled to take the Navy's newest atomic attack aircraft to sea onboard the sea service's first nuclear-powered aircraft-carrier, USS *Enterprise*.

Unfortunately, VAH-7's initial experience with the A3J proved tragic. On 9 January 1962, during the squadron's carrier qualification on board USS *Franklin D. Roosevelt* (CVA-42), the skipper, Commander Bud Gear, hit the ramp and bounced onto the flight deck. For some reason, he was not able to add power to the aircraft, and plunged into the water off the angled deck. Gear was not recovered and his loss, in the words of one squadron pilot, "put a dark blanket over the CarQual bit". Fortunately, the remainder of the squadron completed the qualification without incident and when *Enterprise* departed Norfolk for its first Mediterranean cruise in August 1962, it carried 12 Vigilantes of VAH-7 onboard as part of its air group.

High-visibility NATC markings were applied to the second RA-5C (BuNo. 150824) during its time with the test establishment.

The Cuban Missile Crisis interrupted the voyage of the supercarrier, prompting its return to the United States after only 10 weeks at sea, but this proved more than enough time for the Vigilante to demonstrate its capabilities. Under the command of Commander Louis B. Hoops, the squadron compiled an impressive record, and despite foreign object damage to the engines on a pair of aircraft, the Vigilante's reliability proved outstanding. In September VAH-7 exceeded its flight hour 'quota' by 50 per cent, logging 553.3 hours on 208 sorties that month, with 20 per cent of them ending in night traps on the flight deck of the 'Big E'.

During the cruise, the Vigilante impressed officers of the Royal Navy and French navy during Riptide III, a NATO exercise in the Atlantic in which the aircraft flew simulated atomic strikes against foreign targets, with opposition. This was but one of the exercises in which the squadron participated. In addition to launching simulated strikes against the continental United States as part of LANTFLEX 2-62, VAH-7 Vigilantes staged mock attacks against targets in France and other European nations defended by French navy and United States Air Force fighters. Fall Trap, conducted during the period 23-27 September, included raids against amphibious task forces to simulate the effects of a nuclear attack against an expeditionary force.

'The Peacemakers' logged the Vigilante's second deployment as well, serving once again in *Enterprise* for an extended cruise to the Mediterranean during the period February-September 1963. Under the command of Commander Leroy Heath, the pilot who had shattered the

The trap wire (and the aircraft's nose wheel!) strain under the weight of over 17 tons of Vigilante and the combined thrust of its J79s as the RVAH-3 aircraft lands aboard a carrier during training.

RA-5C training

In preparation for the arrival of RA-5s, the only two A-5Bs delivered to the Navy (BuNos 149300 and 149302) were issued to RVAH-3 'Sea Dragons', the Vigilante fleet replacement squadron (or Readiness Air Group, RAG) at NAS Sanford for flight training purposes. Meanwhile, flight and sensor systems trials on the first RA-5Cs were completed by early 1963, delivery to the Navy beginning on 27 June. RVAH-3 received its first aircraft in January 1964, fleet introduction commencing mid-year when VAH-5 began to re-equip.

world altitude mark in the one of the A3J-1 prototypes, the squadron continued the proud tradition of the previous cruise, garnering the Chief of Naval Operations Annual Safety Award and winning the Heavy Attack Wing One Bomber Stream for the month of September. During one 17-day stretch, VAH-7 Vigilantes amassed 565 flight hours, and during the last three months of the cruise, the landing intervals in the squadron averaged 38 seconds – not bad for an aircraft the size of the A-5. All told, during Fiscal Year 1963 'the Peacemakers' made 1,192 carrier landings and completed 3,927 flight hours ashore and afloat. Squadron crews also made 2,642 practice bombing runs as part of their training from NAS Sanford and off the 'Big E'. In addition, as part of a special operation that put the A-5A's inertial navigation system and radar to work, squadron aircraft participated in a pathfinding mission at sea, locating the carrier USS *Saratoga* (CVA-60) during a mock sea engagement and broadcasting its position for attacking aircraft. Concluded the Heavy Attack Wing annual report, "... the Vigilante should be considered a valuable and effective weapons system that is capable of carrying out any assigned mission in the fleet."

Passionate Pachyderm

Despite these impressive numbers, the personnel of VAH-7 endured the good-natured teasing and disrespect that came with the territory when one was assigned to heavy attack. Fighter and attack pilots who flew the sleek F-8 Crusader and nimble A-4 Skyhawk badgered the 'heavy attack pukes'. One pilot, Lieutenant Commander Wynn Foster, upon hearing the squealing sound the aircraft's J79s made when the pilot added and pulled off power during approach, likened the Vigilante to an elephant. It was a title Leroy Heath took with great pride. Not one to let pass an opportunity to pull one over on the fighter types, he christened his aircraft the *Passionate Pachyderm*. In addition, during one port call a VAH-7 sailor found a little wind-up elephant in a store and bought it for the skipper. Heath painted the Modex number of his aircraft – 701 - on the side of the toy and took to turning it loose to walk in front of the lens of the camera that recorded landings on the flight deck. Since this was broadcast into each squadron's ready room, Heath was able to stage a 'gotcha' on the entire air group. "Heath, I hate heavy attack pukes," the air group commander told the VAH-7 skipper after the stunt, "but I consider you exempt."

Another 'Peacemaker', Lieutenant Commander Ken Enney, took the rivalry a step further. Annoyed after a fighter pilot from VF-32 had jumped him one day during an exercise, he called the offender's ready room and announced that one of these days he was going to take a clean-wing Vigilante up and "teach them some manners". Not too long afterward, Enney was up in an A-5A carrying only one wing tank when he spotted a Crusader piloted by John Disher, a future admiral. "We had quite a flail and John was calling out, 'I can't get rid of this guy!' And he

Their wingtips folded, a pair of RVAH-3 aircraft rest aboard an unidentified carrier during the 1960s. BuNo. 151728 was the last 'new' RA-5C constructed before production was restarted during the Vietnam conflict but was lost in a December 1967 accident.

These early-production RA-5Cs carry RVAH-3 codes over unusual white tails.

With the Golden Gate bridge in the background, USS **Ranger** *(CVA-61) departs San Francisco en route to Hawaii and the South China Sea. Note that all three of the aircraft in this view are from the batch of A-5Bs converted to RA-5C standard. Confined to operations over South Vietnam, RVAH-5 was occupied with providing photographic intelligence to allow the Navy to plan attack routes, especially for its A-6 Intruders.*

'Savage Sons' in SEA

During August 1964 Heavy Attack Wing One became Reconnaissance Attack Wing One (RAtWingOne), the few remaining heavy attack (VAH-) designated squadrons having been redesignated RVAH- during the spring. VAH-5 accordingly became RVAH-5 on 1 May and was issued with a few A-5As for training alongside its first RA-5Cs. As the first fleet squadron to re-equip with RA-5s it prepared to make its first operational deployment, with CVW-9 aboard *Ranger*. After the Tonkin Gulf incident (2 August), *Ranger* joined the build-up in the western Pacific, RVAH-5 thus becoming the first Vigilante unit to be deployed to the region.

didn't get rid of this guy," Enney recalled of the day he played fighter pilot in a nuclear bomber. "When I got back aboard it was sort of the talk of the ship that the A3J had outdone the F-8 straight fighter. You could do that to a point as long as you stayed up around 20,000 [6096 m]. John had to admit that he'd been had and his CO … wasn't too happy about that. They wanted another go at it."

During one cruise with VAH-7, Enney impressed another F-8 driver from USS *Franklin D. Roosevelt*. The A-5As were equipped with electronic countermeasures (ECM) equipment, and as part of one exercise, Enney and another pilot were assigned to find the carrier. The skipper of 'FDR', future Vice

KA-3Bs of 'Heavy Two' provide tanker support for RVAH-5 Vigilantes during the 1964/65 cruise. Also present is a VFP-63 RF-8A. During this, the Vigilante's first deployment, high-risk reconnaissance tasks over North Vietnam were assigned to CVW-9's RF-8As, the sensitivity of the RA-5C's equipment and the Navy's inexperience with the type restricting it to South Vietnamese targets. However, with experience gained, it was not long before the usefulness of its sensors would outweigh any security worries and, before long, 'Vigis' were being sent 'up north'.

RVAH-5's BuNo. 150839, one of the first production RA-5Cs, is prepared for a 'cat shot' from* Ranger *in calm Pacific waters during the 1964/65 deployment.

Admiral Gerry Miller, had manoeuvred his ship into the confined waters, and ceased operating his radar, which had thwarted previous searches during the exercises. However, while the Vigilantes were up, Miller turned his radar on prior to beginning flight operations, just long enough for the A-5s to pinpoint the location of his ship. Although the Vigilante, for some unremembered reason, was prohibited from exceeding 450 kt (830 km/h), Enney staged a low-level pass over 'FDR' at 500 kt (922 km/h), pulling into a climb right over the ship. Had he been carrying any ordnance, he would have plastered the target. While in his climb, the Vigilante driver was joined by one of the carrier's recently catapulted F-8s, and fittingly he acknowledged the fighter pilot with a universal hand gesture!

Operation Sea Orbit

The 'Peacemakers of the Fleet' completed their final cruise with the A-5A between February and October 1964. It concluded with participation in Operation Sea Orbit, the around-the-world cruise of three nuclear-powered ships: *Enterprise*, the cruiser USS *Long Beach* (CGN-9) and the guided-missile destroyer USS *Bainbridge* (DLGN-25). Reminiscent of the Great White Fleet's global encirclement in 1908, the voyage served as an outward demonstration of US naval might, and to this end the Vigilantes of VAH-7 performed low-level supersonic flight demonstrations for dignitaries from Africa, Asia, Australia and South America.

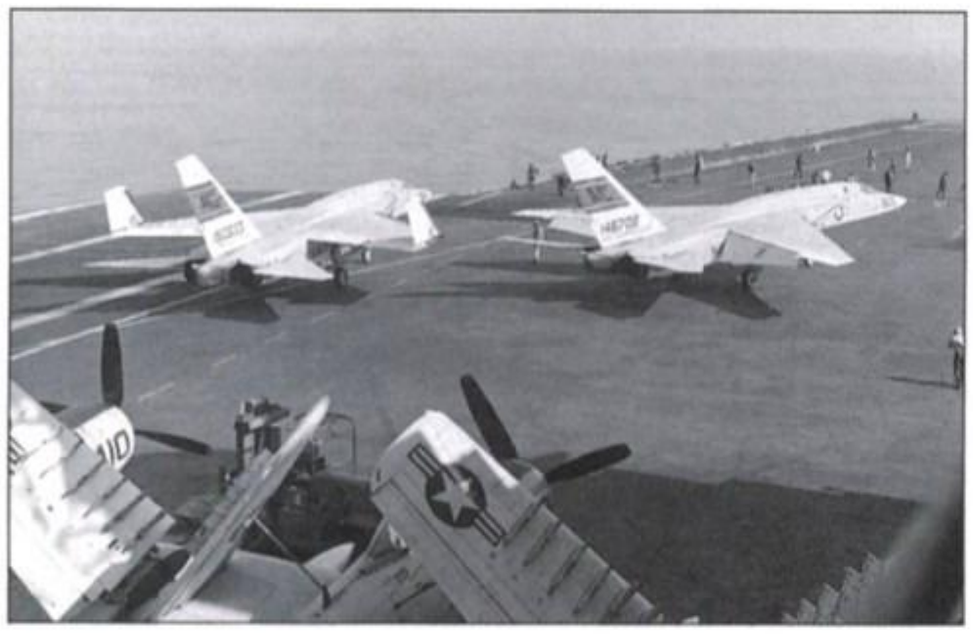
Aside from VAH-7's three cruises in *Enterprise*, VAH-1 operated from USS *Independence* (CVA-62) during an August 1963-March 1964 Mediterranean cruise. For that carrier's skipper, Captain James D. 'Jig Dog' Ramage, operating 12 of the giant aircraft from the flight deck of his ship proved quite a task, for the A-5A "was the most demanding of pilots of any aircraft". In addition, the entire dozen was not all available for operations at the same time during virtually the entire course of the cruise. "This low availability was a direct result of provisioning and complexity," Ramage later recalled. "They [the VAH-1 maintenance crews] were working long hours under good leadership, but the job of maintaining 12 A3Js was just too much, particularly in view of the paucity of spare parts."

While the Vigilante obtained its sea legs with the Sixth Fleet, a *National Geographic* writer and photographer visited *Enterprise* as part of their preparation for a story on the US Navy in the nuclear age. When the article appeared in 1965, the lead photographs included shots of VAH-7 aircraft arrayed on the deck of the world's first nuclear carrier and A-5s operating against a golden sunset. The latter photographs were ironic, for when that particular

With USS* Hancock *(CV-19) steaming nearby, a 'Savage Sons' aircraft is checked over during a lull in operations.

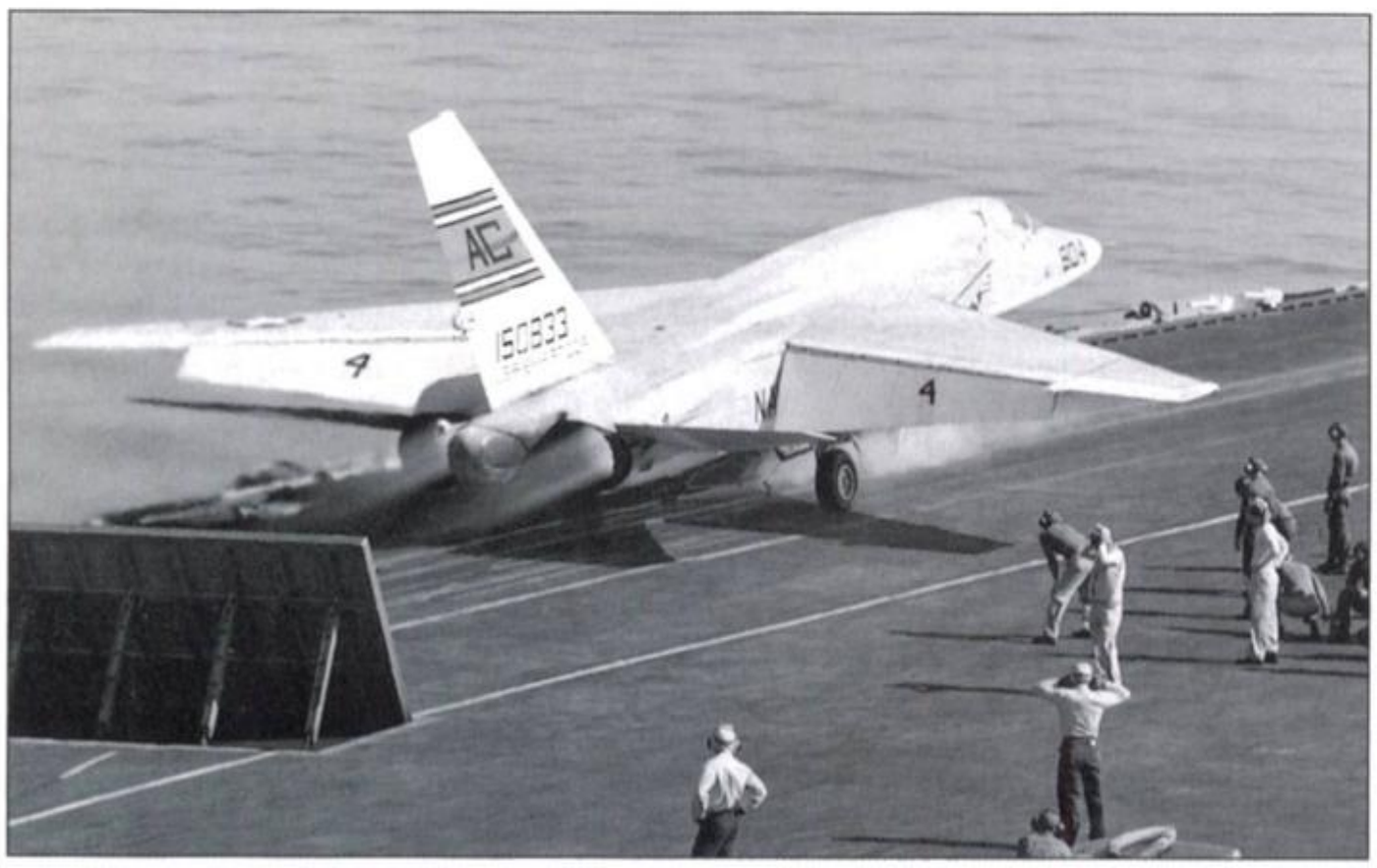
As new-build RA-5Cs began to roll off the Columbus production line, A-5As were also under conversion at the NAA factory. With so many redundant A-5A bombers available for conversion, initial RA-5C production was restricted to 43 airframes. Of the 156 A-5As built, 140 were eventually reconfigured for the reconnaissance role. BuNo. 146701 was one of these aircraft and is seen here shortly after its rebuild.

The 'Hoot Owls' Vigilantes during its second Mediterranean cruise were a mixture of new-build RA-5Cs (like BuNo. 150833, below) and others converted from A-5A standard (BuNo. 146701, far right). CVW-3 included A-1H Skyraiders of VA-176, F-4B Phantoms of VF-31 and A-4B Skyhawks of VA-216.



RVAH-9 in the Med

RVAH-9 was the second operational unit to re-equip with RA-5Cs, having previously flown A-3Bs (A3D-2s) as VAH-9. Transitioning between types in 1964, RVAH-9 began its first cruise in November 1964, joining CVW-3 aboard *Saratoga* (CVA-60) in the Mediterranean. After a period of operations off Vietnam in 1965/66 (aboard *Ranger*), RVAH-9 returned to the Mediterranean in *Saratoga*, in 1967, when these photographs were taken.



sense – another high-altitude bomber," Ramage wrote years later. "It did have a hard wing for loft delivery, but the idea of retrofiring bombs out the stern did not appear to be a good delivery procedure. Of course, this delivery did away with external stores and could provide supersonic speed, but the A3J did not have the range of the A3D."

The difficulties with the aircraft's patented linear bomb bay and aft delivery system did the aircraft no favours in the consideration of the Navy. However, coupling the system's failure with the rising cost of production proved most damning to the Vigilante. Plucked from the chairmanship of the Ford Motor Company by President John F. Kennedy in order to head the Department of Defense, Robert S. McNamara assumed his new post determined to eradicate waste in the Pentagon. As evidenced later by his effort to force the Navy to procure a version of the Air Force's F-111 bomber for use as a fighter interceptor, he would not tolerate wasting money on an aircraft whose mission could be performed adequately by another. In the case of the Vigilante, between FY1962 and FY1963, funding increased from US$177.9 million to more than US$200 million, and cost per aircraft approached US$10 million. Its bomb delivery system made the A3J/A-5 unique, but in the minds of some officers its failure to perform made the Vigilante just another fast jet whose mission could be performed adequately by aircraft such as the A-6 Intruder.

North American hoped that the A3J-2/A-5B version of the Vigilante, first flown on 29 April 1962, might eradicate some of the concern over the aircraft's future. Configured with the provision for increased fuel capacity and tactical weapons delivery using wing pylons, the new aircraft also featured a redesigned flap system that included the

issue hit the news-stands, the Vigilante was no longer the Navy's "newest attack plane", as the magazine stated. Instead, its fortunes had changed, the result of a shift in the roles and missions of the Navy and a widening war in a distant Southeast Asian land called Vietnam.

Ain't going to bomb no more

Even before the Vigilante had ever taken to the air, controversy surrounded it. Captain James D. 'Jig Dog' Ramage commanded Heavy Attack Wing One at Sanford when he received his first detailed information about the A3J. Having been assigned to the Armed Forces Special Weapon Project at Sandia Base in Albuquerque, New Mexico during 1950-1952, he had become convinced of the viability of delivering smaller atomic weapons at low altitude using propeller-driven AD Skyraiders and F2H Banshee jet fighters. While at Sanford, he advanced low-level penetration using the A3D in what became known as Sandblower missions. "It [the Vigilante] simply didn't make

CRAW-1 expansion

The conversion of VAH squadrons to the 'RVAH' role took place fairly rapidly after the initial re-equipments had been completed. VAH-1, -13 and -7 were all redesignated during 1964, re-equipping with RA-5Cs, VAH-6 following in 1965 and VAH-11 on 1 July 1966. All had previously flown A3D-2 (A-3B) Skywarriors. Two units were established from scratch specifically to fly the Vigilante – RVAH-12 (in 1965) and RVAH-14 (in 1968), the latter unit being the last to join the RA-5C 'community'. Soon after the tenth and last unit had formed, RAtWingOne moved to NAS Albany, Georgia where it remained until 1974, when it was relocated to NAS Key West, Florida.

introduction of leading-edge blown flaps. These improvements made for better performance at low speed and high altitude and, coupled with the increase in power provided by the J79-GE-8 engine, allowed a take-off weight of over 80,000 lb (36228 kg). The 'new' Vigilante would never get the chance to prove its mettle to the Navy. Yet, in a strange twist of fate, the decision made at the highest echelons of the Navy – effectively spelling the end of the A-5B – helped advance the Vigilante programme.

In January 1958 Chief of Naval Operations Arleigh Burke approved an OP-23 (Long-Range Objectives Group within the Department of the Navy) study entitled *The Navy of the 1970 Era*, which formed the basis of the sea service's future shipbuilding programme. Central to the plan was the premise that combat operations for the Navy surface forces would generally fall within the sphere of limited war. Mirroring the opinions of Burke, who had long espoused a nuclear weapons doctrine of deterrence as opposed to the massive retaliation embodied by the Air Force's Strategic Air Command, the study placed great emphasis on the construction of submarines capable of launching nuclear missiles. Fittingly, in December 1959 the Navy commissioned its first Fleet Ballistic Missile submarine, USS *George Washington*, and the following year conducted the first successful submerged launch of a Polaris missile. Between FY1957 and FY1961, Congress authorised the construction of 19 Polaris submarines.

While the advent of Polaris did not totally supplant nuclear weapons aboard carriers, it spelled the end of the need for flat-tops to carry out first strike missions in the event of nuclear war. This effectively transformed the once promising A-5 Vigilante into a very expensive aircraft without a mission. By 1963, the Navy decided to halt procurement of the aircraft. While this measure would seem like a major setback for North American, this did not prove to be the case; although the Navy no longer required a heavy bomber, it did have need a more capable fleet reconnaissance aircraft. To this end, even before the cancellation of procurement of the A-5, the company had test flown a new version of the Vigilante, the RA-5C.

From the earliest days of US naval aviation, aerial photography had assumed a degree of importance. Counted among the first combat flights flown by naval aircraft during the Vera Cruz Insurrection in 1914 were photographic and observation missions. The following year Walter Richardson, the Navy's first aerial photographer, reported for duty at Naval Air Station Pensacola, Florida. During World War II many of the classic naval aircraft produced, such as the SBD Dauntless, F4F Wildcat and the F6F Hellcat, included camera-equipped versions for use in photo-reconnaissance. For the first time, the Navy and Marine Corps established squadrons whose primary mission was the gathering of photographic intelligence.

Following the war, the Navy continued to develop its photographic reconnaissance capability, and when war erupted on the Korean peninsula, it played a decisive role.

These aircraft of RVAH-6 'Fleurs' were photographed at NAS North Island, California on 28 April 1966, prior to their first cruise. Note the experimentally camouflaged Vigilante (possibly BuNo. 149313) in the background.

After its initial deployment to WestPac, RVAH-5 made two consecutive deployments to the Mediterranean, in 1965/66 and 1967. These 'AE'-coded 'Mushmouth' aircraft are pictured during one of those cruises. Note the flasher pod on the port wing of the banking aircraft.

***Below: VAH-11 became RVAH-11 in 1966, its second and third cruises taking it to Vietnam aboard USS* Kitty Hawk.**

During the squadron's second deployment on Yankee Station (its first with CVW-11 aboard Kitty Hawk*), a rather weatherbeaten RVAH-11 Vigilante (one of the former A-5Bs) takes fuel from one of VAQ-131's TACOS EKA-3Bs after a combat mission over North Vietnam on 29 January 1968.*

Vietnam

With the return, in May 1965, of RVAH-5 from the South China Sea, four more squadrons were readied for service in the region. RVAH-1 was the first to embark during the summer (in USS *Independence*), with RVAH-13 and -7 following in October (aboard *Kitty Hawk* and *Enterprise*, respectively). Towards the end of the year *Ranger* retuned to the WestPac, this time with RVAH-9 in its air wing. One of the first tasks entrusted to the Vigilantes, given the inaccuracy of American maps of the region, was the provision of imagery of the entire country – a task that took some two weeks to accomplish.

The Vigilante's career in the region spanned nine years, ending with the 1973 ceasefire. Assigned the hazardous pre- and post-strike reconnaissance task, the RA-5C suffered the highest loss rate of an Navy type involved in the conflict. At least 23 were lost during the 31 deployments to the region during the war; 18 of these were directly attributable to enemy action.

Between 1950 and 1953, photo-equipped F2H Banshees and F9F Panthers provided nearly 95 per cent of all intelligence available to naval task forces, and one squadron exposed enough film to circle the globe six times. It was during the uncertain days of the Cuban Missile Crisis in October 1962 that naval air power made a name for itself in the field of photo-reconnaissance. Operating RF-8A Crusaders, pilots of VFP-62 and VMCJ-2 logged repeated low-level missions over Cuba, providing vital intelligence – in the form of 160,000 negatives – to the National Security team in Washington. So successful was the effort that President John F. Kennedy personally presented the Navy Unit Commendation to VFP-62. Into this proud tradition stepped the RA-5C Vigilante.

Cameras versus bombs

In 1959 an article on the history and future of aerial reconnaissance appeared in the United States Naval Institute Proceedings. In discussing the variety and complexity of sensory equipment that would be required in the future of this particular art of war, the author concluded that "the airframe and powerplant to carry the sensors is a system design consideration of first magnitude. ... Make-do conversions of vehicles designed for other basic purposes will not be adequate." The development of the RA-5C Vigilante proved him wrong.

Structurally, the transformation of the A-5A into the RA-5C did not require drastic measures. The only notable changes that were readily visible were the more rounded shape of the top of the fuselage behind the cockpits, the result of an increase in the aircraft's fuel capacity, and a ventral canoe. The latter was essentially a hollowed out section of the fuselage on the bottom of the aircraft, used for placement of the various sensory equipment carried aboard the aircraft. It was in this area that the reconnaissance version of the Vigilante bore no resemblance to its older cousins.

Like the RF-8A, the RA-5C carried a variety of camera equipment at various stations on the aircraft designed to capture an array of images at either high or low altitude, day and night. The ventral canoe included windows slanted for oblique images, side windows through which panoramic images could be taken, and those conducive to vertical

These reconnaissance photographs are typical of the type of intelligence gathered by the Vigilante fleet. Targets included Haiphong harbour (above), SAM sites (with smoke from a SAM launch visible, right) and AAA sites (with firing AAA circled, far right). Pre- and post-strike missions were particularly hazardous, NVN gunners soon learning to anticipate a return visit from a reconnaissance aircraft if they had been visited before a strike.

photography. The sensor station could house various combinations of equipment to fit the requirements of a particular mission.

Extensive camera fit

The camera equipment included framing cameras, which produced a series of sequential photographs that provided complete vertical and oblique coverage all along the aircraft's flight track. Different lenses, ranging from wide-angle to telephoto, could be fitted to these KA-51A/B cameras, and flasher pods allowed for night photography. Carried on the wings, these flasher pods produced high-intensity light in a 43° cone of illumination, but were rarely used during combat operations in Vietnam, where Vigilante crews found them to be a veritable homing beacon for enemy anti-aircraft gunners on the ground. A second category of images could be obtained using two panoramic cameras: an 18-in (457-mm) focal length KA-58A for use at medium to high altitudes and a 3-in (76.2-mm) KA-57A for low-altitude work. By rotating a prism that panned from the ground beneath the aircraft out to the horizon on either side of it, this configuration of cameras provided true horizon-to-horizon coverage.

The reconnaissance attack navigator (RAN) in the rear cockpit had primary control over all cameras, but the pilot could take control of the oblique still picture camera. Drawing upon the Vigilante's days as a bomber, AN/ASB-12 bomb-directing equipment assisted in the stabilisation of some panoramic and serial frame cameras. However, the RAN could cage the system in the event of malfunction in stabilisation. A viewfinder system in the cockpit allowed him to monitor the accuracy of the camera settings.

In addition to the cameras, the Vigilante's aerial reconnaissance package included an array of sensors that recorded a variety of non-visual data. Located aft of the camera windows on the belly of the aircraft, the AN/AAS-21 infra-red detecting set, or IR mapping system, could provide a continuous strip image of infra-red emission patterns within a 140° field of view. More effective when operated at night, the system could detect energy radiated from military vehicles and stockpiled supplies, be it stored heat from the sun or that produced by engines.

For electronic support missions, the RA-5C carried the AN/ALQ-61 Electronic Reconnaissance System. Under the control of the RAN, this system detected emitter signals from enemy radars, ships and surface-to-air missile sites, recording their latitude and longitude, radio frequency, pulse repetition frequency and pulse width. Capable of recording continuously for up to 112 minutes, the AN/ALQ-61 readings appeared on a magnetic tape that could be inserted into a computer and analysed by intelligence personnel.

The first reconnaissance Vigilantes destined to join the fleet were conversions rather than airframes constructed from the ground up as photo-birds. At the time of the decision to shift the mission of the Vigilante, a batch of 18 A3J-2 (A-5B) aircraft was on the verge of being delivered for use in the heavy attack role. Although two were delivered to the fleet in this configuration, four aircraft within the batch were delivered to NAS Sanford after

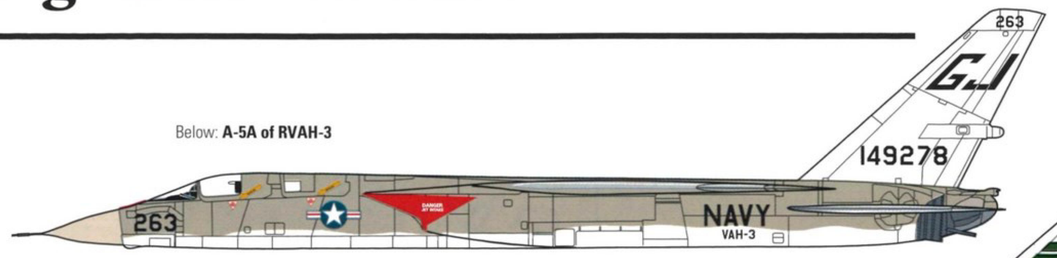
Like any other carrierborne type, the Vigilante suffered its share of mishaps, the likelihood of accidents increasing on the busy decks of carriers in the South China Sea, especially with live ammunition present. The disastrous fire aboard USS Forrestal on 29 July 1967 cost the lives of 134 sailors; 21 aircraft were destroyed or deemed unrepairable, including this RVAH-11 Vigilante – one of three wrecked in the fire – in the process of being jettisoned over the side

Other accidents were not as calamitous, but were equally dramatic for those involved. Here pilot LCdr Art Skelly taxies his 'Vigilante convertible' after landing aboard Constellation, his RAN, Lt(jg) Joe Shevlin, having lost his canopy during a 'cat shot'.

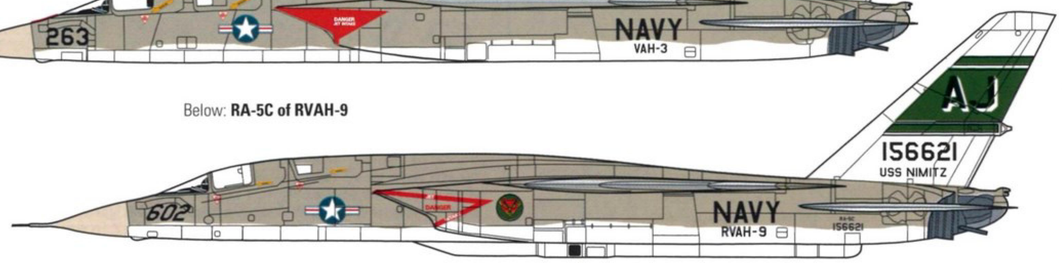
VAH-3 had been redesignated RVAH-3 and its use of the A-5A was coming to an end when this photograph of three of its aircraft was taken in September 1964.

Vigilante Colours

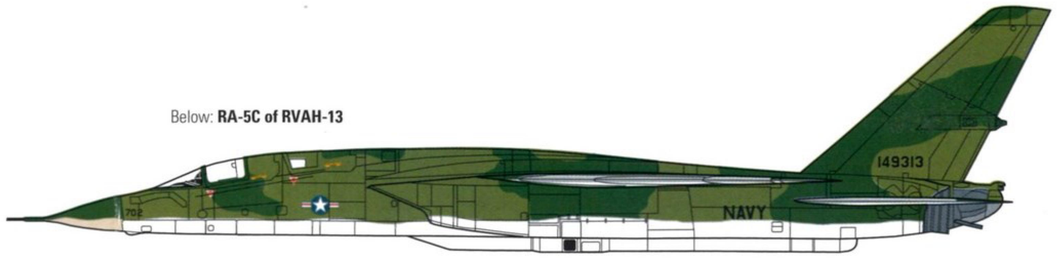
Below: **A-5A of RVAH-3**



Below: **RA-5C of RVAH-9**



Below: **RA-5C of RVAH-13**



Throughout the Vigilante's service life the same basic finish was applied to both A-5As and RA-5Cs. This consisted of F.S.36440 or F.S.16440 Light Gull Gray overall, with F.S.17875 Insignia White undersurfaces. The radome was tan. Markings common to all aircraft (Modex number, ship name, Bureau number and 'NAVY') were black. The only major variation came during Vietnam War camouflage trials, when RVAH-13 aircraft were experimentally finished in a medium green/shadow green/desert tan scheme. At least one aircraft carried a dark green/olive drab variation; neither scheme was adopted.

Below: **RA-5C of RVAH-9**

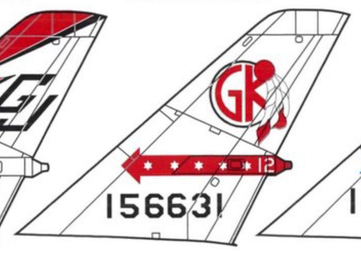
Tail markings

Variations between individual RA-5Cs were largely confined to tail colours and markings. These usually varied during the life of a squadron, but often incorporated a common theme throughout (e.g. the *fleur de lis* as in the RVAH-6 emblem, or the 'speartips' in the RVAH-12's tail marking). Below is a representative selection of Vigilante squadron tails spanning the type's service.

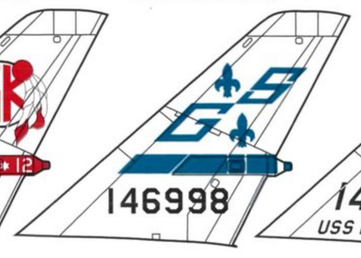
Below: **VAH-1/CVG-7 (1963/64)**

Below: **RVAH-3 (1979)**

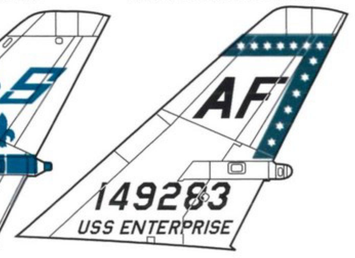
Below: **RVAH-5 (1977)**



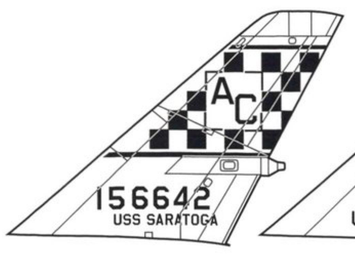
Below: **RVAH-6 (1973)**



Below: **VAH-7/CVG-6 (1962)**

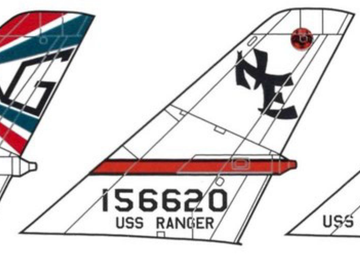


Below: **RVAH-11/CVW-3 (1974/75)**

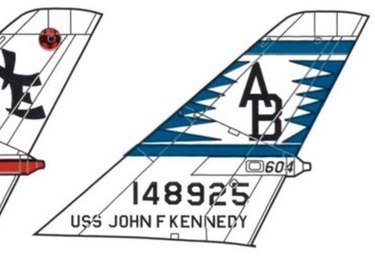


Below: **RVAH-12/CVW-9 (1973)**

Below: **RVAH-13/CVW-2 (1974)**



Below: **RVAH-14/CVW-1 (1969)**



No longer vigilant – preserved RA-5Cs

Given that most surviving A-5As and all the A-5Bs were converted to RA-5C standard, none of the original Vigilante bombers were saved. At least nine RA-5Cs have survived as gate guardians and museum exhibits; six are illustrated here. Among the others are: **BuNo. 146697** (a former Patuxent River gate guard) at the Naval Air Test and Evaluation Museum, Patuxent River; **BuNo. 156643** (the final production RA-5C) also at the NATE Museum; **BuNo. 151629** (formerly stored at AMARC) at the Pueblo Weisbrod Aircraft Museum, Colo.

Above: BuNo. 149289, exhibit Pima Air Museum, Ariz.
Below: BuNo. 156608, gate guard NATTC, NAS Memphis, Tenn.

Above: BuNo. 156612, gate guard NAS Key West, Fla.
Below: BuNo. 156624, exhibit NMNA, Pensacola, Fla.

Above: BuNo. 156643, exhibit NATC Museum, Pax River, Md.
Below: BuNo. 156621, exhibit Air-Sea-Space Museum (USS *Intrepid*), New York; pictured while at NAS Pensacola.

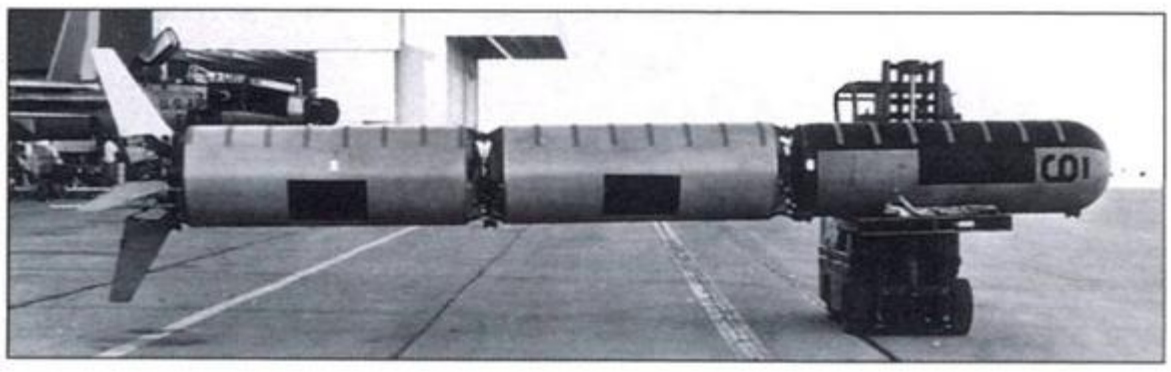
Vigilante weapons

An A-5B prototype poses in time-honoured fashion with the array of stores the type was cleared to carry. These included Mk 28EX free-fall and Mk 43-0 retarded nuclear weapons, AGM-12B Bullpup A and AGM-12C Bullpup B air-to-surface missiles, Mk 82, Mk 83 and Mk 84 iron bombs, 2.75-in FFAR and 5-in 'Zuni' rockets, various sub-munition dispensers, practice bomb dispensers and 400-US gal (1514-litre) drop tanks. The larger pod under the port wing is an RCPP-105-1 power supply pod. Manufactured by Garrett AiResearch, this 1,638-lb (743-kg) store was powered by a small gas turbine and provided power, refrigeration for avionics and the pilot's pressure suit and bleed air to start the engines.

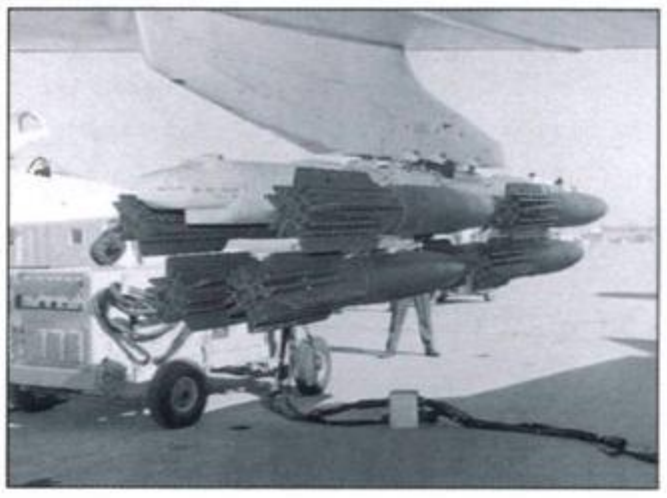
Below: This example of the A-5A's Primary Store Train combines a Mk 43 weapon with the two fuel cans and F-21 fins. Variants of the Mk 27 and Mk 28 weapons were also developed for the A-5A. The lower view shows the Mk 27 in a complete 'bomb train' with fins deployed (by hydraulic rams) as they would after weapon release.

Above: One of the RA-5C prototypes (converted from A-5A standard) was photographed with a variety of warloads in situ. Here BuNo. 146699 is loaded with a pair of Mk 43-0 retarded thermonuclear weapons and a pair of AGM-12B ASMs.

The dolly and winch system (left) used to load the weapon train into the A-5A's bomb bay is seen here. As designed for the Vigilante's store train, the Mk 43 weapon consisted of a sabot warhead and associated carriage unit (lower left). Note also the original AN/ALQ-41/-100 antenna fairing above the weapon tunnel opening.



The RA-5C retained the ability to carry external weapons, including a pair of Mk 28-0 free-fall (left) or Mk 43-3 parachute-retarded (below) nuclear weapons. In practice, the RA-5's wing pylons were rarely used.



Above left: Various external missile and bomb loads were test flown on the RA-5C prototypes, including this load of at least eight Mk 82 Snakeye bombs. The RA-5C retained a full attack capability with external stores though, as far as is known, this was never used.

Vigilante production

NEW-BUILD AIRCRAFT

Variant	*Model No.*	*BuNos*	*Total*
	NA-233	(NAGPAW proposal)	0
YA3J-1	NA-247	145157-145158§	2
A3J-1 (A-5A)	NA-247	146694-146702	9
	NA-263	147850-147863	14
	NA-269	148924-148933	10
	NA-269	149276-149299	24
A3J-2 (A-5B)	NA-269	149300-149317*	18
A3J-3 (RA-5C)	NA-279	150823-150842	20
	NA-283	151615-151634	20
	NA-283	151726-151728	3
	NA-283?	151962-151969	cancelled
RA-5C 'Phase II'	NA-316	156608-156643	36
	NA-316	156644-156653	cancelled
Total production			**156**

RA-5C CONVERSIONS

In all, 140 of the 156 Vigilantes constructed were configured as RA-5Cs, including 79 new-build aircraft, 18 conversions from A-5B and 43 conversions from A-5A

A-5A to RA-5C	NA-296	†	27
A-5A to RA-5C	NA-298	†	16
A-5B to RA-5C	?	149300, 149302, 149306-149317	14
A-5B to YA-5C, then RA-5C	?	149301, 149303-149305	4
Total RA-5C conversions			**61**

§ BuNo. 145157 was originally ordered as an XA3J-1

* BuNos 149300-149317 were originally ordered as A3J-1s

† Forty-three A-5As were converted to RA-5C standard in two batches. The first 27 examples were given new NAA construction numbers upon conversion. These aircraft were: BuNos 145157, 146695, 146696, 146698, 146701, 146702, 147850, 147858, 148925, 148932, 148933, 149276-149281, 149283-149289, 149291, 149293, 149294.

An additional 16 aircraft were also converted, though these retained their original c/ns: BuNos 147852-147854, 147856, 147857, 147859-147861, 148926, 148928, 148929, 149295-149299

North American (Rockwell) RA-5C Vigilante

RVAH-7

'Peacemakers of the Fleet'

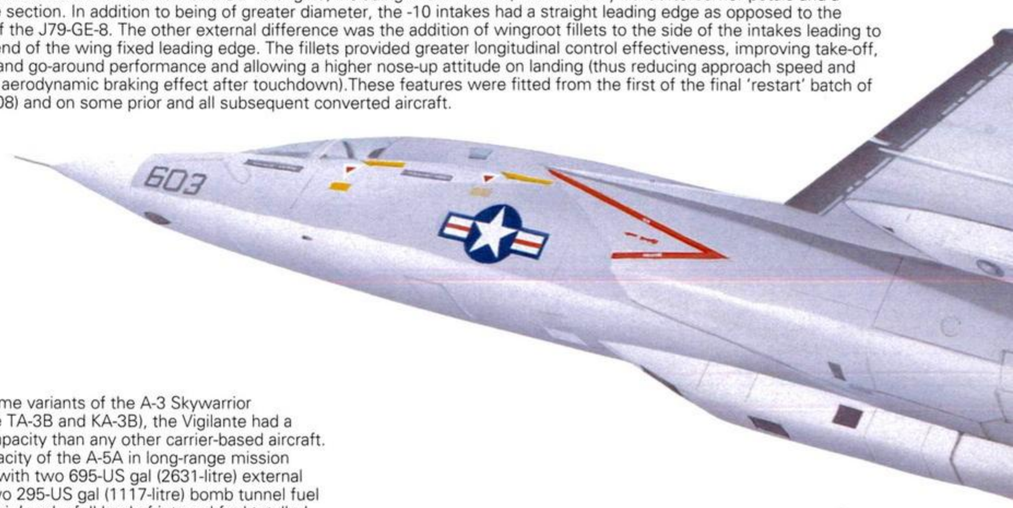
Reconnaissance Attack Wing

CVW-11

USS *Kitty Hawk* (CV-63), 1974

Depicted here as it would have appeared on its penultimate cruise during 1973/74, BuNo. 149298 was the 56th of 57 production A3J-1s built by the North American factory at Columbus Ohio, and was delivered as an A-5A January 1963 and assigned to the Vigilante RAG, VAH-3. By May it had been assigned to VAH-1 and embarked in USS *Independence* (CVA-62) for the squadron's 1963 cruise. Joining VAH-7 in early-1964 (and being deployed in USS *Enterprise* (CVAN-65) during its cruise later in the year), BuNo. 149298 remained with the squadron, which was soon redesignated RVAH-7, until November 1964. Placed in the custody of the Bureau of Naval Weapons at NAS Olathe, Kansas two months later, the aircraft was subsequently returned to the North American plant in Columbus, Ohio for conversion to RA-5C standard.

Its first assignment after conversion was with RVAH-11 at NAS Albany, Georgia, in August 1967 where it remained until June 1968, when it was reassigned to RVAH-14, and deployed in USS *John F. Kennedy* (CVA-67) during its 1968/69 cruise. Thereafter it served with RVAH-13 (from February 1970; deployed in USS *Forrestal* (CVA-59) for its 1970 cruise) and RVAH-12 (in March 1971; deployed in USS *Independence* (CVA-62) that same year) before being sent to the Naval Air Rework Facility (NARF) at Jacksonville, Florida, in May 1972. There the aircraft remained until June 1973, at which time it was reassigned to RVAH-7 at NAS Albany, deploying with the squadron in USS *Kitty Hawk* (CVA-63) during 1973/74. RVAH-7 moved to NAS Key West, Florida in 1974, but by December the Vigilante had moved on again and was now assigned to the RAG (RVAH-3). Its move in October 1976 to RVAH-1 was to be its last as an effective airframe, and after a spell in *Enterprise* (CVN-65) in 1976/77, BuNo. 149298 was transferred once again to the NARF at Jacksonville in August 1977 where it was retired and finally stricken on 3 August 1979.



Late-model RA-5C

The '1969-model RA-5C' as a North American company brochure put it, had a number of visible differences from those preceding. Most of these were related to the new J79-GE-10 engine, including wider intakes, more heavily-built afterburner petals and a longer tail pipe section. In addition to being of greater diameter, the -10 intakes had a straight leading edge as opposed to the curved edge of the J79-GE-8. The other external difference was the addition of wingroot fillets to the side of the intakes leading to the outboard end of the wing fixed leading edge. The fillets provided greater longitudinal control effectiveness, improving take-off, single-engine and go-around performance and allowing a higher nose-up attitude on landing (thus reducing approach speed and increasing the aerodynamic braking effect after touchdown).These features were fitted from the first of the final 'restart' batch of RA-5Cs (156608) and on some prior and all subsequent converted aircraft.

Fuel

Apart from some variants of the A-3 Skywarrior (principally the TA-3B and KA-3B), the Vigilante had a greater fuel capacity than any other carrier-based aircraft. The basic capacity of the A-5A in long-range mission configuration with two 695-US gal (2631-litre) external drop tanks, two 295-US gal (1117-litre) bomb tunnel fuel cans in the 'train' and a full load of internal fuel totalled 3,605 US gal (13646 litres) of JP-5, equivalent to 24,514 lb (11120 kg). The RA-5C added an overwing tank and larger forward tanks in its revised 'top cap' or 'hump back' fuselage. With four 400-US gal (1514-litre) drop tanks and three bomb tunnel tanks, capacity rose to a massive 4,905 US gal (18567 litres) or 33,354 lb (15129 kg) – equivalent to the empty weight of three-and-a-half A-4C Skyhawks!

Wing tanks were infrequently carried as their weight and drag tended to cancel out the range benefit they provided. F-4 Phantoms employed as escorts for RA-5 missions in Vietnam could not keep up with the 'Vigi' in minimum afterburner as they needed to carry a centreline tank, whereas the reconnaissance aircraft had enough range to reach the Philippines from the Tonkin Gulf on internal fuel if necessary – an occasional requirement when commanders needed instant 'hard copy' intelligence.

Sensor 'canoe'

The heart of the RA-5C's capability lay in its ventral sensor 'canoe', the photograph Vigilante to gather day/night, high-resolution images in a variety of speed, altitude well as cameras the 'canoe' also carried a side-looking airborne radar (SLAR) syste system and a so-called passive electronic counter measures (PECM) system, thou better described as a passive Elint suite. Controlled via a panel in the RAN's cockp operate the oblique still cameras if necessary), the camera fit carried could be vari particular mission; during the course of the Vigilante's career mission requirement very low altitudes, especially during service in Vietnam. Sensor stations within the were as follows:

Station 1 :	(forward oblique) KA-51A or KA-51B 6-in focal length camera on fixed mounts (with two
Station 2	(azimuth/vertical camera) KA-50A 1¾-in, KA-62A 3-in or KA-51A 6-in focal length in an a
Station 3, 6	AN/ALQ-61 PECM equipment (multi-band passive detection and recording set for Elint c
Station 4	one of three modules in five configurations (Module 4-1: right and left oblique cameras various depression angles; Module 4-1 configuration A: as Module 4-1, but with 3-in fo compartment of Module; Module 4-2: provision for KA-58A 18-in focal length panorami KA-57A 3-in focal length panoramic camera in rear compartment; Module 4-3 two 6-i additional 1¾-in focal length camera; Module 4-3 configuration A: one 12-in focal length vertical cameras in forward compartment
Station 5	miscellaneous electronic equipment
Station 7	AN/AAS-21 IR detecting (mapping) system
Station 8	Westinghouse AN/APD-7 SLAR

Radar and avionics

The A-5 and RA-5 had many innovative features for an aircraft designed in the mid-1950s. The AN/ASB–12 bombing system included a Convair-designed J-band 'general purpose' radar, an Eastman Kodak optical bomb sight and a North American Autonetics computer. The integrated inertial navigation system (INS) of which the radar was a part was derived from that designed by NA Autonetics for the Navajo missile and was known as REINS (radar-equipped INS). The ASB-12 was connected to the first production head-up display (HUD) fitted to a combat aircraft. This was sometimes called the Flight Projected Indicator or the Pilot's Projected Display Indicator (PPDI).

The nose radome had a powered upwards folding mechanism to make room in the hangar deck. The radar itself, together with the ASB-12 package, hinged downwards for access, eliminating the need for a maintenance platform. The Verdan (Versatile digital analyzer) digital computer was one of the first high-capacity miniaturised computers ever built into an aircraft design. Early reliability of the computer and related systems was not high, a mean time between failures (MTBF) of only 15 minutes was the norm on test aircraft by December 1959. By August 1960, this had improved to 78 hours, and by 1961, the unit had to be removed for repair only once every 240 hours, or 10 months of flying operations.

Bomb tunnel

The Minneapolis-Honeywell company was responsible for the unique linear bomb bay system of the Vigilante. Although the concept was simple, the execution was complex, and difficulties with the system contributed to the removal of the Vigilante's strike role. In nuclear strike configuration, the nuclear weapon was mounted forward, followed by two 295-US gal (1117-litre) fuel tanks and then the tail cone, which was held on by three catches and jettisoned first to begin the bomb drop sequence. The core of the system was a bomb train running on rails and activated by a solid-fuel cartridge propelled catapult or 'kicker'. At the other end, folding fins were attached to the last fuel tank and the whole unit fell on the target together. Recommended bombing method was a toss manoeuvre with bomb release taking place in a vertical climb with the bomb eventually slowing down and flipping over as the aircraft escaped in an 'Immelmann' manoeuvre. A weakness of the linear bomb tunnel system was the propensity for inertia to result in the 'train' being left behind on the flight deck if the shock of the catapult shot (estimated at 23 *g*) broke its restraints. In the A-5A, the bomb train could be replaced with one of several packages including three 295-US gal (1117-litre) welded aluminium fuel cans or a buddy refuelling kit consisting of three fuel tanks and a hose reel and drogue basket

Even in RA-5 configuration a nuclear capability was retained with provision for carriage of Mk 43 weapons (as well as a range of conventional ordnance) on the wing pylons, although this was not a formal part of the RECONATKRON's stated role and was rarely if ever practised.

Radar/Attack Navigator

The Radar/Attack Navigator (RAN) sat in a separate cockpit behind the pilot. The space was so small that he could touch any surface within it with his elbow. Unlike the F-4 Phantom and most other tandem-seat naval aircraft, the backseater had no forward view past the pilot whatsoever, his only view was through a tiny window on each side of the hinged metal canopy and on the screen of his radar TV indicator which was linked to the undernose TV camera contained in a smooth fairing behind the radome.There were no flight controls in the RAN's cockpit, naval reasoning being that a carrier landing was impossible to fly from the back seat and that the only option in the case of pilot incapcitation was command ejection by the backseater of both occupants. On the definitive RA-5C navigator's station, an optical viewfinder joined the radar-TV indicator, replacing the data viewer scope of the A-5A/B. On the upper part of the panel nine dial-type instruments replaced the four of the A-5A. The RAN controlled all the cameras and reconnaissance systems, and monitored camera readiness and exposures remaining, but the pilot could take over control of the oblique still cameras to photograph targets of opportunity.

Undercarriage

The Vigilante was fitted with a Bendix-manufactured hydraulically-retracting undercarriage system. All units retracted forward with the mainwheels rotating 90° to fit in the wells. In the case of hydraulic failure, a manual system released all the uplocks and allowed the undercarriage to drop under gravity. Each unit had a single wheel, the mainwheels with 36 x 11 high-pressure tyres (250 psi/1724 kPa) for shipboard use) and the steerable nosewheel with a 26 x 6.6 tyre. Brakes were of the multiple disc type actuated by the No.2 hydraulic system which was good for three maximum brake applications and 12 lesser applications per landing and parking operation. Later aircraft were fitted with an anti-skid system. The nose gear was 14 feet (4.27 m) behind the cockpit which made deck handling a matter of trust between the pilot and the plane directors as in many manoeuvres the cockpit overhung the deck edge and the pilot had little idea of exact positioning of the nosewheel.

Integrated Operational Intelligence Center

Information gathered by the equipment in the sensory 'canoe' was processed by the IOIC immediately the aircraft returned to its carrier, allowing a highly accurate 'picture' of the area of interest to be presented to commanders. Film magazines were passed to the film handling dark room, while magnetic tape processors dealt with downloaded data from the PECM set. From the magnetic media a map overlay could be produced for use in conjunction with the photographic intelligence gathered. IOICs were installed in a number of attack carriers and included a large specialised crew comprising air intelligence officers, photographic interpreters and photographers mates, data processors and avionics and radar technicians. All were trained ashore by RVAH-3's Special Class Photographic Laboratory.

RA-5C

del RA-5C' as a North American company brochure put it, had a number of visible differences from those preceding. were related to the new J79-GE-10 engine, including wider intakes, more heavily-built afterburner petals and a e section. In addition to being of greater diameter, the -10 intakes had a straight leading edge as opposed to the f the J79-GE-8. The other external difference was the addition of wingroot fillets to the side of the intakes leading to end of the wing fixed leading edge. The fillets provided greater longitudinal control effectiveness, improving take-off, and go-around performance and allowing a higher nose-up attitude on landing (thus reducing approach speed and aerodynamic braking effect after touchdown).These features were fitted from the first of the final 'restart' batch of 08) and on some prior and all subsequent converted aircraft.

me variants of the A-3 Skywarrior TA-3B and KA-3B), the Vigilante had a pacity than any other carrier-based aircraft. acity of the A-5A in long-range mission with two 695-US gal (2631-litre) external o 295-US gal (1117-litre) bomb tunnel fuel ain' and a full load of internal fuel totalled 13646 litres) of JP-5, equivalent to 20 kg). The RA-5C added an overwing tank vard tanks in its revised 'top cap' or 'hump . With four 400-US gal (1514-litre) drop e bomb tunnel tanks, capacity rose to a US gal (18567 litres) or 33,354 lb quivalent to the empty weight of three-and-yhawks!

s were infrequently carried as their weight ed to cancel out the range benefit they Phantoms employed as escorts for RA-5 etnam could not keep up with the 'Vigi' in rburner as they needed to carry a centreline the reconnaissance aircraft had enough the Philippines from the Tonkin Gulf on necessary – an occasional requirement nders needed instant 'hard copy'

Sensor 'canoe'

The heart of the RA-5C's capability lay in its ventral sensor 'canoe', the photographic systems installed allowing the Vigilante to gather day/night, high-resolution images in a variety of speed, altitude and atmospheric conditions. As well as cameras the 'canoe' also carried a side-looking airborne radar (SLAR) system, an infra-red (IR) detection system and a so-called passive electronic counter measures (PECM) system, though this latter item would be better described as a passive Elint suite. Controlled via a panel in the RAN's cockpit (though the pilot was able to operate the oblique still cameras if necessary), the camera fit carried could be varied according to the aims of a particular mission; during the course of the Vigilante's career mission requirements changed from medium-level to very low altitudes, especially during service in Vietnam. Sensor stations within the 'canoe', and their equipment, were as follows:

Station 1 : (forward oblique) KA-51A or KA-51B 6-in focal length camera on fixed mounts (with two depression angles – 11° 30' or 16°)
Station 2 (azimuth/vertical camera) KA-50A 1¾-in, KA-62A 3-in or KA-51A 6-in focal length in an azimuth-controlled mount
Station 3, 6 AN/ALQ-61 PECM equipment (multi-band passive detection and recording set for Elint collection)
Station 4 one of three modules in five configurations (Module 4-1: right and left oblique cameras of various focal lengths mounted at various depression angles; Module 4-1 configuration A: as Module 4-1, but with 3-in focal length panoramic camera in aft compartment of Module; Module 4-2: provision for KA-58A 18-in focal length panoramic camera in forward compartment and KA-57A 3-in focal length panoramic camera in rear compartment; Module 4-3 two 6-in focal length cameras and provision for additional 1¾-in focal length camera; Module 4-3 configuration A: one 12-in focal length vertical or two 12-in focal length split-vertical cameras in forward compartment
Station 5 miscellaneous electronic equipment
Station 7 AN/AAS-21 IR detecting (mapping) system
Station 8 Westinghouse AN/APD-7 SLAR

Supersonic night flasher system

To aid night photography using the 6-in focal length vertical cameras (stations 2 and 4) electronic flasher pods could be carried on the wings (at station 9, the inboard wing attcahment point). These were built into fairings rated for supersonic flight and consisted of three strobes and a ram air turbine mounted on the aft end to provide power. Although effective, the flashes of the pods' strobe lights gave away the RA-5's position to enemy defences, and they were not often used after the early days in Vietnam. An infra-red version was developed to work in conjunction with IR film, but this too was little used, most night reconnaissance missions being conducted with the SLAR.

RVAH-7 'Peacemakers of the Fleet'

As part of Heavy Attack Wing One (HAtWingOne), formed in February 1951 with the AJ-1 Savage, Heavy Attack Squadron Seven (VAH-7) nominally transitioned from the A3D-2 Skywarrior to the A3J-1 in August 1961, although its first Vigilantes did not arrive until January the following year. The squadron adopted the 'Peacemakers' nickname with the new aircraft.

VAH-7's third and final Mediterranean cruise with the A-5A was notable for the route it took back to the US, rather than the time spent on station. *Enterprise* (CVAN-65) joined with the cruiser USS *Long Beach* (CGN-9) and the frigate USS *Bainbridge* (DLGN-25) for Operation Sea Orbit in which the three ships rounded Africa and South America en route to Norfolk, thus completing a round-the-world cruise and proving the ability of the 'nuclear Navy' to conduct prolonged global deployments.

In August 1964, the Peacemakers began conversion to the RA-5C and the reconnaissance role. Redesignation to RVAH-7 took place on 1 December. The parent organisation of the RA-5C squadrons was renamed Reconnaissance Attack Wing One (RAtWingOne) in August 1964. In October 1965, again aboard *Enterprise*, the 'Peacemakers' made their first combat cruise to Vietnamese waters during which the unit lost one aircraft in combat on 16 December 1965 and another in an accident on 6 October 1966.

There was little time for rest before RVAH-7's second combat cruise, from 19 November 1966 to 6 July 1967 during which another combat loss was suffered. Two more Vietnam deployments on USS *Constellation* (CVA-64) and USS *Kitty Hawk* (CVA-63) were interspersed with Mediterranean and WestPac cruises until the squadron made its final Vigilante carrier cruise, beginning in February 1979.

Nominal shore-based code letters were 'GL', but the A-5As wore 'AF' and 'AE' on their three cruises and the RA-5Cs were assigned 'AA', 'AG', 'NE', NG', 'NH' and 'NK' depending upon the fleet (and, therefore, air wing) to which the unit was assigned. RVAH-7 made the last carrier landing by a Vigilante, aboard *Ranger* on 17 August 1979 (crewed by LCdr Habel and Lt Parr) and the last catapult launch on 21 September 1979 (Cdr Myers and LCdr McManamon) landing at Key West. On 28 September 1979, the squadron was disestablished and Reconnaissance Attack Wing One followed it into the history books on 7 January 1980.

ge

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manufactured
tracting undercarriage
ts retracted forward with the
tating 90° to fit in the wells. In the case
ure, a manual system released all the
owed the undercarriage to drop under
nit had a single wheel, the mainwheels
gh-pressure tyres (250 psi/1724 kPa) for
and the steerable nosewheel with a
rakes were of the multiple disc type
No.2 hydraulic system which was good
num brake applications and 12 lesser
r landing and parking operation. Later
ted with an anti-skid system. The nose
et (4.27 m) behind the cockpit which
dling a matter of trust between the pilot
irectors as in many manoeuvres the
g the deck edge and the pilot had little
sitioning of the nosewheel.

Integrated Operational Intelligence Center

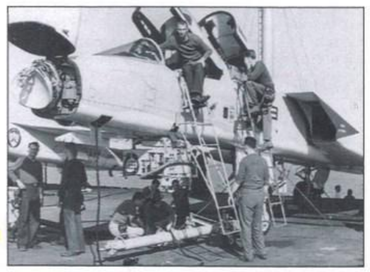
Information gathered by the equipment in the sensory 'canoe' was processed by the IOIC immediately the aircraft returned to its carrier, allowing a highly accurate 'picture' of the area of interest to be presented to commanders. Film magazines were passed to the film handling dark room, while magnetic tape processors dealt with downloaded data from the PECM set. From the magnetic media a map overlay could be produced for use in conjunction with the photographic intelligence gathered. IOICs were installed in a number of attack carriers and included a large specialised crew comprising air intelligence officers, photographic interpreters and photographers mates, data processors and avionics and radar technicians. All were trained ashore by RVAH-3's Special Class Photographic Laboratory.

Tail surfaces

The tail fin was a single-piece pivoting slab, one of the first applications of this type of control surface in a combat aircraft. Tail travel was restricted by flap position to two degrees left or right with flaps up and eight degrees each way with flaps lowered to 25° or more. To allow stowage of the aircraft below decks the upper 3 ft 10 in (1.19m) of the fin folded to the left. The fin tip contained a so-called 'scimitar' duplex antenna for the TACAN/UHF communications system.

The tailend fuselage fairing contained the fuel dump vent and antennas for the defensive ECM system. The horizontal tail provided pitch change through symmetrical movements and roll trim with small asymmetrical deflection, but did not provide actual roll control, which was the job of the wing spoilers. Deflection of the leading edge was possible within a range of 15° up and 18° down.

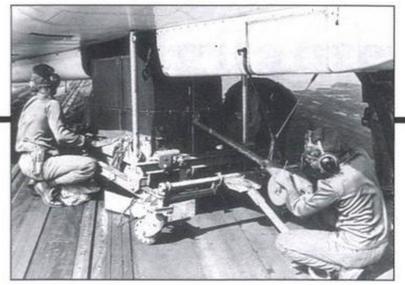
Vigilante details



Left: The A-5A's nose radome was hinged to fold upward, revealing the General Dynamics radar. This was integrated with the North American Autonetics AN/ASB-12 bomb directing set, part of the inertial navigation system (REINS). Fitted to all Vigilantes, the ASB-12 allowed RA-5Cs to accurately aim their sensors and retain an attack capability.

Right: The fairing immediately behind the radome of a production RA-5C was normally transparent and contained an Eastman Kodak television scanner. Television imagery was displayed on the pilot's projected display indicator (PPDI, the first operational HUD) and the RAN's radar screen.

The Vigilante's forward-retracting nose gear was of a typical NAA design similar to that of other NAA aircraft. The main gear was double-hinged, retracting forwards and sideways.

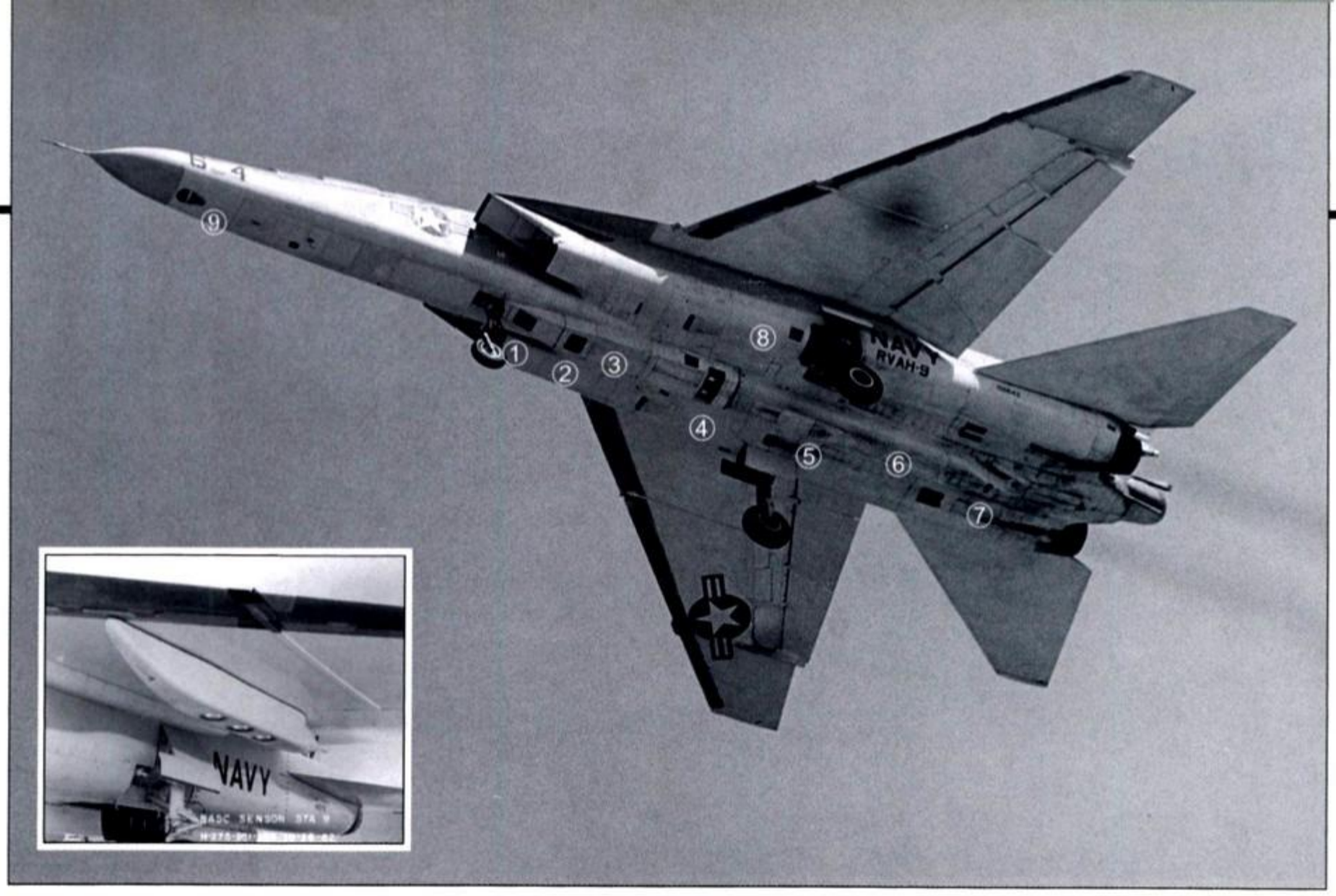


Photographers Mates prepare to hoist a camera module from its dolly into position at Station 4 in the sensor 'canoe'.

A technician removes a film canister from a KA-51/53 series camera in one of the Vigilante's camera stations. Severa major camera manufacturers supplied such equipment for the Vigilante.

RA-5C Vigilante cutaway

1 Pitot static boom
2 Hinged radome
3 Search radar antenna
4 Hinged radar and AN/ASB-12 forward package (servicing position)
5 TV optical scanner
6 Inflight refuelling line
7 Inflight refuelling probe (stowed)
8 AN/ASB-12 bomb directing set
9 Radome actuator
10 Radome (folded)
11 LOX converter
12 Instrument panel shroud
13 One-piece acrylic windscreen
14 Radar-flight projected display indicator
15 Control column
16 Rudder controls
17 TACAN antenna
18 ADF antenna
19 AN/APR-27 antenna
20 Viewfinder
21 Pilot's ejection seat
22 Underseat high-pressure emergency oxygen bottle
23 Cockpit air supply
24 Canopy emergency air bottle
25 Headrest
26 Pilot's canopy
27 Emergency escape system ballistic charges
28 Pilot's canopy actuator
29 Indicating power supply
30 Bombing computer
31 UHF antenna
32 Radar altimeter
33 AN/ALQ-100 antenna
34 Navigator's side console
35 Underseat high-pressure emergency oxygen bottle
36 Navigator's ejection seat
37 Canopy emergency air bottle
38 Navigator's window
39 Headrest
40 Navigator's canopy actuator
41 LOX storage converters (2)
42 Master flight reference gyro
43 Nosewheel well
44 Pre-closing nosewheel doors
45 Nosewheel gear steering unit
46 Taxiing light
47 Forward-retracting nosewheel
48 Nosewheel centering unit
49 Nosewheel gear actuator
50 Flight control main electronics bay
51 Flight control relays
52 IFF antenna
53 Bulkhead
54 Forward fuselage fuel cell (455 US gal/1722 litres)
55 Inlet sidewall structure
56 Forward variable ramp
57 Nacelle inlet assembly
58 Port intake
59 Nacelle structure
60 Aft variable ramp
61 Ramp actuator
62 Intake duct
63 (Ventral) launch catapult hooks (2)
64 Main wing/fuselage frame forging
65 Wing forward attachment pick-up point
66 BLC ducting
67 Fuselage sump fuel cell (490 US gal/1855 litres)
68 Starboard wing-root fillet
69 Starboard auxiliary drop-tanks (400 US gal/514 litres each)
70 AN/ALQ-41 and -100 forward transmit antennas
71 AN/APR-25 and AN/ALQ-41 and -100 forward receive antennas
72 Leading-edge wing-droop (inner section)
73 Droop actuator and torque rod
74 Conduit towing fold (hydraulic and electrical)
75 Wing structure
76 Starboard wing integral fuel (715 US gal/2707 litres)
77 Span-wise corrugated stiffeners
78 Wing-fold line
79 Leading-edge wing-droop (outer section)
80 Starboard navigation lights
81 Starboard formation light
82 Wing outer section (folded)
83 Outboard spoiler deflector (downward airflow)
84 AN/ALQ-4 and-100 aft receiver antennas
85 Central (closed) and inboard spoiler deflectors (upward airflow)
86 Starboard flaps
87 BLC flap-blowing duct
88 Wing aft attachment pick-up point
89 Dorsal fairing
90 Overwing saddle tank (210 US gal/795 litres)
91 Wing centreline splice assembly
92 Starboard intake ducting
93 Bomb-bay forward fuel cell
94 Hydraulic reservoir air storage tank
95 Port intake ducting
96 Port mainwheel well
97 Retraction jack
98 Universal pivot
99 Mainwheel leg down-lock
100 Wing aft attachment pick-up point
101 Steel mainframe and firewall (canted)
102 General Electric J79-GE-10 turbojet
103 BLC cross-over ducting
104 Bomb-bay central fuel cell
105 No. 1 hydraulic system reservoir
106 No. 2 hydraulic system reservoir
107 Aft fuselage saddle tank (130 US gal/492 litres)
108 Anti-collision beacon
109 Starboard engine oil tank (6.1 US gal/23 litres)
110 Fuselage aft structure
111 Horizontal stabiliser
112 Horizontal stabiliser attachment frame
113 Horizontal stabiliser actuator
114 Vertical stabiliser actuator
115 Bomb-bay aft fuel cell (total internal capacity: 885 US gal/3350 litres)
116 Fuselage aft frame
117 Vertical stabiliser pivot
118 Vertical stabiliser lowersection structure
119 Conduits (front to rear: electrical, hydraulic, tail-fold cable)
120 Leading-edge dielectric panel
121 Tail-fold hinge line
122 Tail-fold actuator
123 Vertical stabilizer upper-section structure
124 Front spar
125 Duplex UHF comm/ALQ-55 antenna
126 Electrical conduit
127 Vertical stabilizer (folded)
128 Rear formation light
129 DECM antenna, AN/APR-18, AN/APR-25(v) or AN/ALR-45(v)
130 Buddy tanker lights
131 Fuel vent
132 AN/APR-18 antenna, if fitted
133 Fuel vent line
134 Electrical conduits
135 Honeycomb structure
136 Tailcone
137 DECM boom antenna, AN/ALQ-100
138 As item 137, AN/ALQ-41
139 Exhaust nozzle fairing
140 Variable-area convergent-divergent expansion nozzle
141 Honeycomb structure
142 Horizontal stabiliser structure
143 Horizontal stabiliser pivot
144 Machined end rib
145 Pivot attachment frame
146 Afterburner
147 Exhaust nozzle cable pulley feedback system
148 Arresting hook
149 Launch catapult holdback yoke
150 Central and inboard spoiler deflectors
151 Wing spoiler actuators
152 Port flaps
153 Trailing-edge honeycomb structure
154 Outboard spoiler deflector
155 AN/ALQ-41 and-100 aft receiver antennas
156 Outer section wing structure
157 Compass
158 Port formation light
159 Port navigation lights
160 Outer section leading-edge droop
161 Droop actuator and torque rod
162 Wing-fold actuator
163 Wing-fold hinge line
164 Span-wise stiffeners
165 Stores pylons
166 Port wing integral fuel (715 US gal/2707 litres)
167 Port auxiliary drop-tanks (400 US gal/514 litres) (or flasher pod for night photography, inboard pylons only)
168 AN/APR-25 and AN/ALQ-41 and -180 forward receiver antennas
169 High-strength alloy Bendix mainwheel gear
170 Port mainwheel
171 Modularised multi-sensor ventral reconnaissance pod
172 PECM (Passive electronics counter-measures) antenna
173 Side-looking airborne radar (SLAR) AN/APD-7 (and infra-red sensor AN/AAS-21 below, not shown)
174 PECM canisters
175 Reconnaissance electronics equipment
176 IMC and camera control unit
177 Recorder amplifier
178 Data converter
179 Band 11 and 12 receivers
180 Interchangeable camera module (two side oblique serial frame cameras, two panoramic cameras. or two vertical serial frame cameras)
181 PECM antennas, AN/ALQ-61
182 Vertical serial frame camera (KA-50 or -51)
183 Forward oblique serial frame camera (KA-51A)



This worm's eye view of an RA-5C gives a good impression of its reconnaissance sensor canoe and the various systems positions: ① forward oblique camera, ② vertical camera, ③ PECM antenna, ④ panoramic, vertical and/or oblique camera combination, ⑤ IR sensor, ⑥ SLAR, ⑦ PECM antenna, ⑧ chaff dispenser and ⑨ television scanner. Note also the leading-edge root extensions and straight intake wall lip to the engine intakes – both features of late production RA-5Cs with J79-GE-10 powerplants.

Inset: For capturing imagery at night the RA-5C could be fitted with a pair of underwing flasher pods, each with three strobe lights. A small turbine to the rear of the pod provided power. Though useful in peaceful circumstances, the flasher pod was little used in Vietnam as it gave away an aircraft's position to AAA/SAM sites.

Specification

A3J-1 (A-5A) Vigilante

Powerplant: two General Electric J79-GE-8 turbojets each rated at 16,500 lb st (73.4 kN) with maximum afterburner

Dimensions: span 53 ft (16.17 m); span (folded) 42 ft (12.8 m); wing area 700 sq ft (65.03 m²); length 76 ft 6 in (23.35 m); length (with vertical fin and radome folded) 65 ft 4⅜ in (19.92 m); height 19 ft 4¾ in (5.91 m); height (with vertical tail folded) 15 ft 6 in (4.72 m)

Weights: empty 32,714 lb (14839 kg); basic 33,124 lb (15025 kg); combat 47,530 lb (21 559 kg); maximum take-off (field or catapult) 56,293 lb (25534 kg); maximum landing (field) 55,160 lb (25020 kg); maximum landing (arrested) 38,500 lb (17463 kg); overload take-off weight 62,953 lb (28555 kg)

Performance: maximum speed 806 mph (1297 km/h) at sea level; 1,320 mph (2124 km/h) at 40,000 ft (12192 m); initial climb rate 8,000 ft (2438 m) per minute at sea level; service ceiling 52,100 ft (15880 m); combat radius (attack) 1,289 miles (2026 km); ferry range 1,807 miles (2908 km)

Armament: one Mk 27, Mk 28 or Mk 43 nuclear store in the linear weapons bay, plus osne Mk 43 nuclear weapon or a pair of Mk 83 or Mk 84 GP bombs on a weapon pylon under each wing

RA-5C Vigilante (late production)

Powerplant: two General Electric J79-GE-10 turbojets each rated at 17,900 lb (79.63 kN) thrust with maximum afterburner

Dimensions: span 53 ft (16.17 m); span (folded) 42 ft (12.8 m); wing area 753.7 sq ft (70.02 m²); length 76 ft 6 in (23.35 m); length (with vertical fin and radome folded) 65 ft 4⅜ in (19.92 m); height 19 ft 4¾ in (5.91 m); height (with vertical tail folded) 15 ft 6 in (4.72 m)

Weights: empty 37,498 lb (17024 kg); basic 38,219 lb (17336 kg); combat 55,617 lb (25227 kg); maximum take-off (field or catapult) 79,588 lb (36133 kg); maximum landing (field) 65,988 lb (29931 kg); maximum landing (arrested) 47,000 lb (21319 kg)

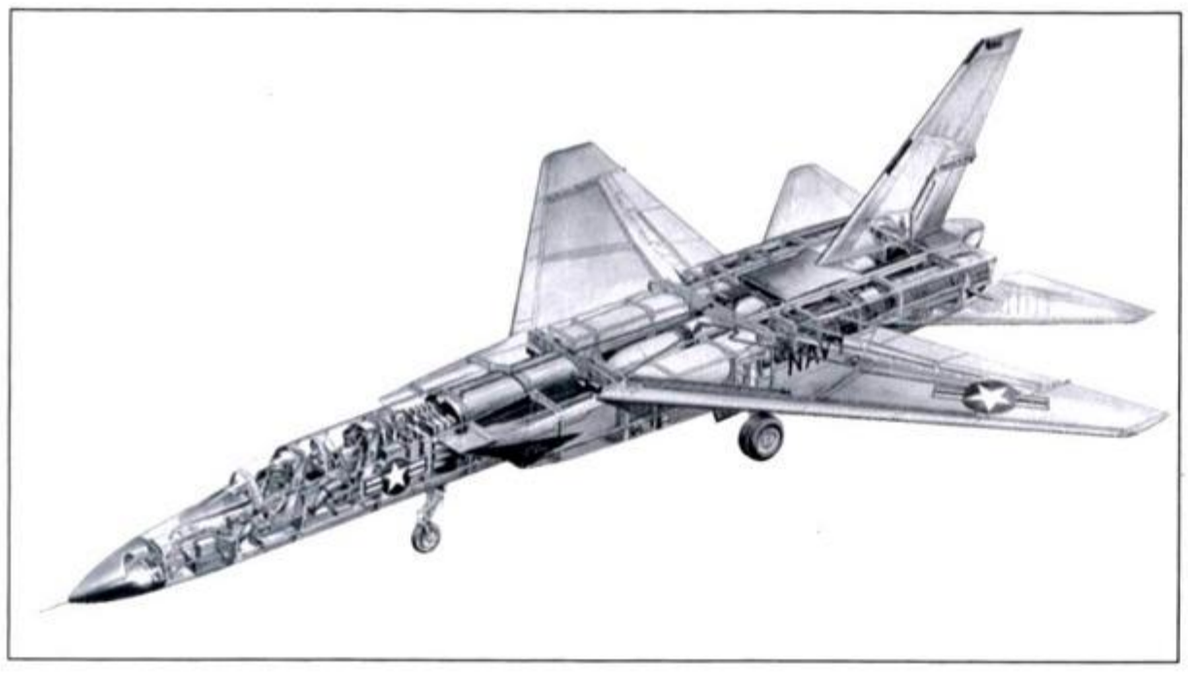
Performance: maximum speed 806 mph (1297 km/h) at sea level; 1,320 mph (2124 km/h) at 40,000 ft (12192 m); initial climb rate 6,600 ft (2012 m) per minute at sea level; service ceiling 49,000 ft (14935 m); combat radius (attack) 1,284 miles (2066 km); combat radius 1,508 miles (2427 km); ferry range 2,050 miles (3299 km)

Armament: none normally carried, though two pylons could be fitted under each wing and a full weapons delivery capability was retained

Left: The Vigilante was one of the first aircraft to employ variable geometry engine air intakes to decelerate supersonic air to subsonic speed before it reached the engine's compressor. The intakes remained unchanged during production until the J79-GE-10 was fitted, late in RA-5C production (as above). The intake pictured is that of a pre-10 RA-5C with a curved intake wall lip and smaller intake throat.

Right: While the linear weapons bay tailcone fitted to A-5As was designed to be jettisoned prior to the launch of a weapon, and was thus expendable, that fitted to the RA-5C (in which fuel tanks were installed in the redundant weapons bay) was only removed for maintenance purposes. That illustrated is the most common tailcone design fitted to J79-GE-8-powered aircraft. Note the retracted fuel dump tube below the fairing and the AN/ALQ-41/ -100 antennas above.

These general arrangement cutaway views of the A-5A (below left) and RA-5C (below) give some idea of the greatly increased fuel capacity of the latter. The principal changes were to the tanks contained in the enlarged spine of the RA-5C. The two tanks immediately aft of the RAN's cockpit were enlarged to hold 945 US gal (3577 litres), compared to 695 US gal (2631 litres) in the A-5A, while an entirely new overwing tank straddling the wing centre-section (omitted from the cutaway) held 210 US gal (795 litres).



BuNo. 149313 was photographed while at NAS North Island on 28 April 1966. The exact shades and patterns applied to Vigilantes varied considerably. This aircraft appears to be devoid of the tan shade seen on other aircraft, sporting a dark green/olive drab scheme.

Camouflage trials

As Navy involvement in the Vietnam War grew, concerns regarding aircraft conspicuity over the Southeast Asian jungle led to research and development into tactical colour schemes for carrierborne aircraft. After the initial painting of a single A-6A of VA-42, a full-scale experiment was organised involving aircraft from CVW-11, embarked in *Kitty Hawk*, and CVW-15, in *Constellation*. Beginning on 11 March 1966, a cross-section of fighter, attack and reconnaissance types from both wings were painted in a variety of temporary schemes, including RA-5Cs of RVAH-13, which wore a medium green/shadow green/desert tan scheme applied by Nippi, the aircraft overhaul firm based at NAS Atsugi, Japan. Results were controversial, and after it appeared that loss rates among camouflaged attack aircraft were higher than those suffered by those in the standard scheme, the experiment was abandoned in July.

Below: On some aircraft pronounced 'scalloping' was used in the demarcation line between the camouflaged upper surfaces and the white under surfaces. Note also the white Modex number and black radome on BuNo. 150834, one of the Vigilantes painted in the three-tone scheme. Some sources describe this an RVAH-6 aircraft.

This photograph (location and date unknown) shows an RVAH-11 aircraft in the two-tone green and brown camouflage scheme trialled by RVAH-13. There are no known records linking 'Heavy 11' with the tactical paint trials and it is believed that this aircraft had earlier served with RVAH-13.

conversion to YA-5Cs, which lacked photo-reconnaissance equipment but possessed the same flight characteristics pilots could expect to find in the RA-5C. The quartet served as trainers, providing a foundation for prospective crews. The remaining 12 aircraft were held back for a time awaiting conversion. Eventually, all 18 aircraft within this batch would see service as RA-5Cs.

In addition, North American manufactured 43 photo-reconnaissance Vigilantes, and reconfigured the same number of A-5As into RA-5Cs. The maiden flight of the RA-5C (at the time the A3J-3) occurred on 30 June 1962, and the first RA-5C was delivered to NAS Sanford on 10 December 1963. So successful was the aircraft during the height of the Vietnam War that, after the RA-5C production line had been closed, the Navy requested more airframes. North American initiated production again, and ultimately produced 36 additional RA-5Cs.

The end of the heavy attack mission came swiftly for those in the Vigilante community. By mid-1964, VAH-5 began converting to the RA-5C in preparation for taking the aircraft to sea. At the same time, the last of the A-5As was returned to the North American plant at Columbus, Ohio, for conversion to photo-reconnaissance duties. Finally, the VAH designation became a thing of the past for

Above: One of RVAH-13's Vigilantes cruises over Vietnamese jungle. Viewed from above the three-tone tactical scheme was effective, but the biggest threat to these aircraft lay not with MiGs but with AAA and SAMs; if anything, camouflaged aircraft were more conspicuous from the ground. One of the main problems associated with the camouflaged aircraft was their virtual invisibility on the deck during night operations.

Vigilante squadrons, which from spring 1964 were redesignated Reconnaissance Heavy Attack Squadrons (RVAH). In short order, Heavy Attack Wing One (HATWING ONE), the Sanford-based command that for so many years had carried the nuclear torch for naval aviation, was renamed Reconnaissance Attack Wing One (RECONATKWING ONE).

Although it initially took some time for the those trained to drop bombs to assume the mindset of triggering a camera over an enemy target, the photo-reconnaissance mission eventually became ingrained in the members of the Vigilante community. "Pat O'Gara, who was CO [commanding officer] of the RAG, RVAH-3, every so often used to get up at All Officers Meetings and scrawl a big 'RVAH' on the board," recalled 'Boom' Powell of his transition training in RA-5Cs in 1969. "First, he'd scratch out the 'A,' saying the attack role was long gone. Then he'd scribble out the 'H' – that, he said, was left over from the A-3. That left the 'R' for reconnaissance. That's what we were … period. Later, when I was a 'Recce RAG' instructor, we'd fine anyone who referred to a 'heavy' squadron."

As more squadrons converted to the RA-5C and deployed aboard ship, it was important that the aircraft be a success. By converting an expensive nuclear bomber to an even more expensive photo-reconnaissance platform, the Navy had staked much on the Vigilante. A letter written by Rear Admiral Robert Goldthwaite, a former HATWING ONE skipper, to the Deputy Chief of Naval Operations (Air) in April 1965, illuminates this fact. "We have just begun to see daylight in this very important programme," he wrote. "Our aircraft accident rate has improved considerably. During the last months of 1964 we experienced an extremely high accident rate; we are fortunate to have no RA-5C accidents thus far in 1965. Planning stability is essential in order to control fleet introduction and readiness of this *most expensive weapons system* [author's italics]."

As is always the case, success or failure depended on the pilots and reconnaissance attack navigators who launched from carrier decks and the ground echelons who kept them flying. In the case of the RA-5C, the learning curve was steep, for the aircraft's maiden cruise was not in tranquil waters, but in the Tonkin Gulf off the coast of Vietnam.

Air war Vietnam

The involvement of the United States in Vietnam escalated when the US Navy destroyers *Maddox* and *Turner Joy* were attacked by North Vietnamese torpedo boats while operating in the Gulf of Tonkin. In response, on 5 August 1964 the US Navy carriers *Constellation* (CVA-64) and *Ticonderoga* (CVA-14) launched retaliatory strikes against North Vietnamese military installations and a petroleum depot. The following year, after limited aerial operations that included armed reconnaissance flights over Laos and another retaliatory strike against North Vietnam in response to attacks against US personnel in South Vietnam, President Lyndon B. Johnson initiated Operation Rolling Thunder.

The inauguration of Rolling Thunder required the use of all of naval aviation's combat assets, particularly the primary photo-reconnaissance platforms. Although the operation certainly expanded the air war over North Vietnam, it was conducted under strict rules of engagement. Targets, except on rare occasions, were generally limited to the enemy communication network and petroleum-oil-lubricant (POL) facilities. Enemy airfields and the MiG fighters based there were off-limits, as were air defences near civilian population centres. In addition, ports like Haiphong were immune to attack, which allowed ships carrying war materiel to offload their cargo at will. Even the ordnance employed against certain targets was subject to the decision-makers in Washington. Finally, periodic bombing halts were ordered whenever the North Vietnamese seemed to lean toward heading to the peace table. In reality, these halts only allowed an unhindered strengthening of defences.

This policy of high-level micromanagement of the war proved frustrating to those tasked with executing it. "If you go to war you clobber them with all you have," one admiral lamented in his diary in 1967. "You certainly don't let the enemy be in a position to control the intensity of

Of the various camouflage schemes tested by CVW-11 during 1966, that applied to the RA-5Cs at NAS Atsugi was judged the most effective and closely resembled the 'Southeast Asia' scheme employed by USAF aircraft from late 1965. The single-colour Field Green (dark olive) scheme applied to some attack types was judged the least effective. BuNo. 150834 is seen here having 'trapped' after another mission.

Prior to the camouflage experiments, the busy deck of* Kitty Hawk *is seen sometime during the carrier's 1965/66 cruise, with a CVW-11 F-4B and A-6A about to launch, and an RVAH-13 'Bats' Vigilante waiting in the queue for the starboard bow 'cat'.

Above: The pressure put on the Vigilante fleet by the prolonged conflict in Southeast Asia resulted in an order for attrition replacement airframes being placed in 1968. These aircraft (BuNos 156608-156643) were delivered during 1969/70. This shot of two CVW-9 aircraft is dated around the time of the wing's 1971/72 Vietnam cruise.

Right: Framed under the wing of a CVW-2 A-7 Corsair equipped for an Iron Hand mission, an RVAH-5 Vigilante is catapulted from the deck of USS Ranger, sometime in late 1969. Note the Sea King plane guard off the ship's starboard side.

Below: Another late production 'Vigi' leaves the deck of Constellation in April 1972, two months before the carrier returned to the States at the conclusion of what was to be RVAH-11's last cruise in the region.

the conflict. ... We bomb some targets selected by LBJ, if you believe what goes on, then we call off the bombing and the NVA laughs." For the pilots, it proved not only frustrating, but also extremely dangerous.

Rolling Thunder operations generally fell into two categories. The vast majority of the time, naval aviators flew armed reconnaissance missions against such targets as trucks and bridges in an attempt to curtail the flow of supplies heading into South Vietnam via the Ho Chi Minh Trail. Aircraft operating in pairs often flew these missions. Occasionally, the powers in Washington approved large-scale strikes against targets of much greater significance, namely POL facilities, power plants and factories. These strikes included a significant portion of a carrier air wing's aircraft, including fighters as escorts against enemy MiGs and flak suppressors, aircraft devoted to attacking the enemy SAM sites with anti-radiation missiles, and between 20 and 30 bombers. It was as part of this air campaign against North Vietnam that the RA-5C Vigilante received its baptism of fire.

Operating from USS *Ranger* (CVA-61), which entered Vietnamese waters in the wake of the Tonkin Gulf incident described above, the Vigilantes of RVAH-5 became the first RA-5Cs to enter combat. However, the squadron's time in-theatre coincided with a policy of limited military response to isolated North Vietnamese and Viet Cong military actions. Even when combat strikes were launched, they were prohibitive. The relative inexperience with the RA-5C, coupled with the aircraft's valuable aerial reconnaissance equipment, limited the Vigilantes to flights over South Vietnam, which did not boast the dangerous anti-aircraft defences that could be found in North Vietnam. Nevertheless, during this cruise the Vigilantes performed the valuable mission of obtaining reconnaissance photographs employed in the development of attack routes for naval strike aircraft, in particular the new A-6 Intruder all-weather attack aircraft that made its combat debut in 1965.

Subsequent cruises placed the Vigilante increasingly in harm's way as it became an important element of naval air operations in North Vietnam. The RF-8 Crusader provided an effective light photo-reconnaissance platform that consisted mainly of aerial photography, but it could not

Vigilante combat losses

date	BuNo.	unit/carrier	crew
20 Oct 65	151615	RVAH-1/*Independence*	LCdr Bell/LCdr Hutton
15 Dec 65	151633	RVAH-7/*Enterprise*	Lt Sutor/Lt(jg) Dresser
20 Dec 65	151624	RVAH-13/*Kitty Hawk*	LCdr Johnson/LCdr Nordahl
22 Dec 65	151632	RVAH-13/*Kitty Hawk*	LCdr Lukenbach/LCdr Daigel
3 Feb 66	151625	RVAH-13/*Kitty Hawk*	Lt Coffee/Lt(jg) Hanson
19 Aug 66	149309	RVAH-6/*Constellation*	LCdr Thompson/Lt(jg) Parten
26 Oct 66	150830	RVAH-6/*Constellation*	LCdr Kolstad/Lt(jg) Klennert
12 Feb 67	151623	RVAH-7/*Enterprise*	Cdr Jarvis/Lt(jg) Artzlip
9 Mar 67	151627	RVAH-13/*Kitty Hawk*	Cdr Putnam/Lt(jg) Pendergast
19 May 67	150826	RVAH-13/*Kitty Hawk*	Cdr Griffen/Lt Walters
13 Aug 67	151634	RVAH-7/*Constellation*	LCdr Hyatt/Lt(jg) Goodermote
5 May 68	149278	RVAH-1/*Enterprise*	Lt Norrington/Lt Tangeman
18 May 68	149283	RVAH-11/*Constellation*	Cdr James/LCdr Monroe
25 Nov 68	149293	RVAH-5/*Constellation*	Cdr Stamm/Lt(jg) Thum
31 Mar 69	150842	RVAH-6/*Enterprise*	Cdr White/Lt Carpenter
7 May 72	151618	RVAH-7/*Kitty Hawk*	Cdr Polfer/Lt(jg) Kernan
7 Jun 72	156616	RVAH-1/*Saratoga*	LCdr Smith/Lt Kunz
28 Dec 72	156633	RVAH-13/*Enterprise*	LCdr Agnew/Lt Haifley

Lt Cdr Art Skelly, RVAH-7's commanding officer and a veteran of 260 combat sorties in the Vigilante by war's end, relates the story behind this unusually finished aircraft (BuNo. 151628): "The yellow Vigi was one of my RVAH-7 aircraft from the Kitty Hawk *in 1972. The yellow was zinc chromate primer as the aircraft was being sent to NAS Cubi Point for corrosion repairs and repainting. A large portion of the aircraft was painted yellow so I told the maintenance crew to paint the entire aircraft yellow. I wanted to fly it over North Vietnam, but the schedule would not allow it. I wonder what kind of reaction we would have gotten from the NVN if they had seen our 'yellow' bird. The aircraft was repainted and returned to the carrier about 10 days later".*

compare to the array of photographic and electronic detection equipment carried by the RA-5C. "That thing was like a big sponge," was one pilot's description of the Vigilante. "We had a 6-in forward camera, side-looking cameras [and] side-looking radar. We had infra-red and we had what was called a PECM package that just picked up everything that was being transmitted."

In addition, the aircraft was an element of the Integrated Operational Intelligence Center (IOIC) that equipped large-deck carriers. Reconnaissance information gathered by the RA-5C's PECM was recorded on a magnetic tape and fed into the system along with the unexposed rolls of film captured by its cameras. The IOIC rapidly processed the reams of data and could produce prints of the reconnaissance photographs 10 minutes after the aircraft landed aboard the ship. Using this data it could formulate an overall intelligence 'read out' that could be used by strike planners and transmitted to other ships that were part of the IOIC network. "Its [the RA-5C's] capabilities as part of the IOIC gave us intelligence far superior to what the RF-8 could provide," recalled one Vietnam-era carrier division commander. "I used it effectively in strike planning."

During the war in Vietnam the carrier served as a platform for power projection ashore, and the pace of operations on Yankee Station, the operating area in the Gulf of Tonkin off North Vietnam, was intense. In support of Operation Rolling Thunder, aircraft operated around the clock, with individual carriers assigned 12-hour shifts in which they sent their aircraft into action. Photo-reconnaissance and other intelligence largely determined targeting for the missions flown by strike aircraft. Therefore, RA-5C Vigilante crews stayed quite busy.

Combat: the view from the cockpit

Generally, the combat flights assigned to the RA-5C Vigilante crews fell into two categories. The first, and most important when it came to strike planning, were pre-strike reconnaissance missions and post-strike bomb damage assessment flights. Though Alpha strikes were relatively

Above: With everything down and its engines producing clouds of smoke, an RVAH-6 'Fleurs' aircraft prepares to touch down at the extreme rear of America's *deck during its 1972/73 Vietnam cruise. The Vigilante's approach speed envelope was narrow for a carrierborne aircraft – getting it right was critical. Little wonder that this phase of carrier flight was the most testing for the Vigilante's RAN, unable to see ahead from his cramped cockpit.*

Left: During RVAH-1's last stint in Vietnam during 1972/73, one of the unit's Vigilante's from the attrition batch is catapulted from the deck of Saratoga.

Before he is catapulted from the deck of **Independence** *on RVAH-14's last cruise, the pilot of this 'Eagle Eyes' Vigilante looks for last-minute hand signals from a deck crewman.*

The beginning of the end

With the end of the Vietnam conflict came the first disestablishments. The Navy no longer had a need for 10 Vigilante squadrons and, besides, by 1973 squadrons were embarking just three aircraft as attrition and spares shortages took their toll. The 'last in – first out' principal was applied and the juniormost member of the Vigilante community was the first to go. RVAH-14 passed into history on 1 May 1974, its surviving aircraft being distributed among the remaining units.

limited due to the restrictions placed on the air war by officials in Washington, the order to launch necessitated accurate intelligence of the target area. The major question strike planners asked was "where were the AAA and SAM sites?" and it was the job of the Vigilante to bring back accurate photographs of the area so that commanders could plan the ingress/egress routes of the strike group, and brief the crews as to what they might expect when over the target.

Following the strike, a lone RA-5C was assigned the mission of flying over the target once again, this time to capture images of the damage inflicted by the attackers. Armed with these photographs, commanders could ascertain the success or failure of the strike, and determine whether another attack against the target was necessary. In obtaining bomb damage assessment photographs, Vigilante pilots earned their pay cheques, for these were the most dangerous flights in the reconnaissance business. Over the course of the air war, it did not take long for North Vietnamese gunners and missile operators to figure out that, following an air strike, it was only a matter of time before a reconnaissance aircraft flew over the target to gather photographs. Thus, they were ready, with fingers on the triggers and firing buttons. "I'd been a bomber pilot [flying AD Skyraiders in Korea] and I tried to time my time over the target just as the last bomb contacted," recalled Captain Charlie James. "That was just for my safety. ... And also, when you went by the major targets there, you'd swing wide and pick-up all the landscape in the surrounding area."

Ken Enney's first BDA over North Vietnam in an RA-5C Vigilante in late 1965 provides an indication of the importance of the reconnaissance mission. "The first mission I had up north in an RA-5 was against [a power plant northeast of Hanoi]. I think the Air Force had gone in there a couple of days before. Allegedly, 40 F-105s completely destroyed the plant. The assessment that we brought back indicated no damage except there were a couple of bombs in the coal [storage area of the plant]." Armed with this intelligence, three carriers launched Alpha strikes against the target, obliterating the plant.

On another occasion, an RVAH-7 bird from USS *Enterprise* conducted a mission southwest of Hanoi, bringing back photographs of a camouflaged surface-to-air missile site containing 10 missiles ready to launch at incoming attack aircraft. Armed with this intelligence, Navy carriers sent the first strike of the following morning against the deadly missiles, destroying all of them on their launchers and giving the aircraft behind them cause to breathe a little easier.

With the paucity of Alpha strikes, many a reconnaissance mission for Vigilante crews involved "just going out in the various route packages [operating areas of Vietnam either assigned to the Air Force or Navy] and looking for potential targets." Utilising the RA-5C's array of sensory equipment, other missions were flown at night high above North Vietnam, usually at an altitude of about 35,000 ft (10668 m). Rather than obtaining photographic reconnaissance, the goal of these sorties was to obtain electronic intelligence.

"When we'd go up there at night and make a run at 35,000 ft up across Laos and back through [North] Vietnam, that was just general information ... that they could use later on. It kind of updated their information that they had for the surrounding areas," Vigilante RAN Colin Pemberton recalled. The infra-red equipment carried by the RA-5C also made it a suitable platform for night search

BuNo. 147859 'AB/601' roars off the deck of 'JFK' 'somewhere in the Mediterranean' in June 1972. CVA-67 was a new ship of the 'Improved Forrestal'-class, having been commissioned in 1968, and was the last conventionally-powered carrier built for the US Navy.

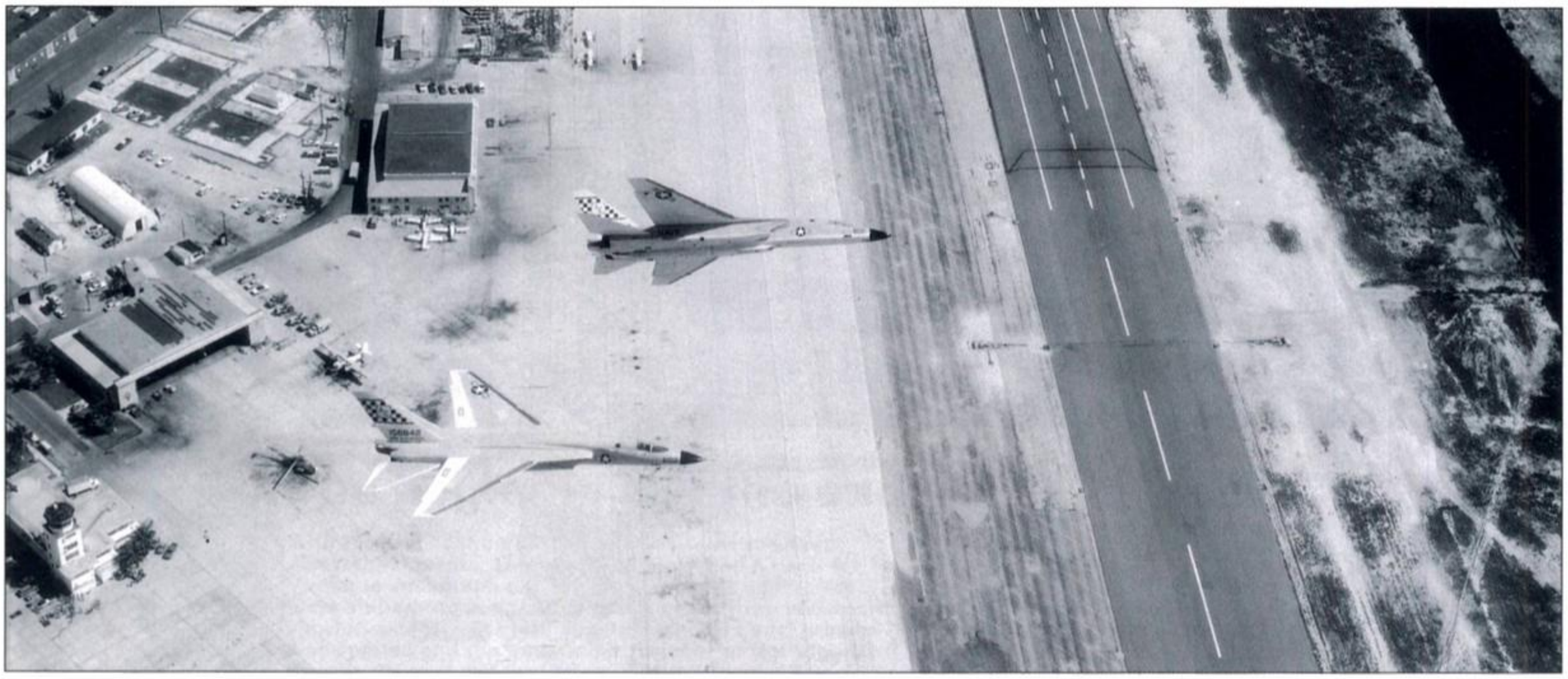
North American (Rockwell) RA-5C Vigilante
RVAH-14 'Eagle Eyes', CVW-1
USS *John F. Kennedy* (CVA-67)
Sixth Fleet, 1972

Wing and fin folding
The section of the wing outboard of the control surfaces could be folded hydraulically (and independently, if necessary), reducing overall span by 11 ft (3.35 m). Wing locks were operated manually from the cockpit. The vertical tail could also be folded, at a point about mid-height. Hydraulic or manual actuation could be used, overall height being reduced from 19 ft 4 in (5.89 m) to 15 ft 6 in (4.72 m).

Automatic Flight Control System (AFCS)
The Vigilante's AFCS provided automatic control of longitudinal and lateral flight control systems from low speeds at sea level to Mach 2 at around 55,000 ft (16764 m), though the pilot was able to make small stick corrections in the pitching and rolling planes without disengaging the system. Flight controls were hydraulically powered (with a stand-by mechanical system) and irreversible, though they were electrically controlled – the first fly-by-wire system in an operational type.

Established at NAS Sanford in 1968, RVAH-14 was the only Vigilante unit (other than the RAG, RVAH-3) not to be deployed to WestPac during the Vietnam war. Attached to the Sixth fleet, it made four deployments in all; three aboard USS *John F. Kennedy* and its last, in 1973/74, in *Independence*. The last RA-5C squadron to be established, the 'Eagle Eyes' was operational for just six years before becoming the first RVAH to disestablish, in July 1974. BuNo. 148925 'AB/604' started life as an A-5A before returning to Columbus for RA-5C conversion. It was finally stricken at the MASDC in May 1974.

Anti-icing measures
Though the Vigilante's air conditioning system provided cockpit windshield and engine intake anti-icing, there was no provision for airframe anti-icing. Flying the aircraft in known icing conditions was not recommended.



Above: RVAH-13 passed into history in 1976. BuNo. 149276 was seen, strapped down aboard* Independence, *on 23 November 1975 during the unit's final cruise.

Top: One of a pair of black-nosed 'Checkertails' aircraft breaks to land as it overflies the tower at NAS Key West. The pair's 'AC' tailcodes indicate that the photograph was taken around the time of (or immediately after?) the squadron's last carrier deployment in 1974/75. RVAH-11 was the second Vigilante unit to disestablish, on 1 June 1975.

missions along the intricate road networks of the Ho Chi Minh Trail and along the river networks of the region. "We'd cover roads looking for traffic. You'd cover rivers looking for waterborne stuff," one pilot remembered. "The first night I really went out and did it, the thing worked good and we found all sorts of bridges that we didn't know were there. They were underwater. But after you run on them, they heat up and you pick up all the bridges that way. You were down fairly low. We had the first tinting of IR and you had to be fairly close."

"An exact science"

Whatever the mission, operations in the RA-5C Vigilante involved much preparation before the crewmen even boarded the aircraft. Given the fact that the aircraft was part of such an intricate system as the IOIC and that by nature the requirements of reconnaissance were precise, the entire operation was, in the words of one pilot, "an exact science". One combat-experienced A-4 pilot who transitioned to RA-5Cs described it in this way. "In attack you're briefed and shown your targets. Usually it was a matter of hanging on to someone else's wing and, once you rolled in, you looked up and hopefully found what you were looking for. In reconnaissance, you spend long hours in detailed planning. Often you have nine or 10 targets to cover, and it's imperative that preplanned parameters over each target be adhered to in order to get usable imagery."

"It was a lot of work to be done," commented Charlie James. "For instance, if we were going to fly in at night, we'd time that thing. You had to have the exact speed and the exact bank angle, and everything had to be real precise. And if you lost your inertial navigation, you'd probably pull out because you'd be down on the hills. Everything was planned very meticulously and you had to hit your angle of bank just right on time, just like flying an instrument pattern. You were tracking with infra-red and side-looking radar."

Colin Pemberton recalled a typical combat flight from launch to recovery. "They had these big yellow carts and they would hook them up about an hour or an hour and a half before [the mission]. They got the gyros all spinning and all the information put in. The electronics people would have all this stuff spinning and getting it all tuned up and set in. ... They already had the present position in because that's what it took to get the equipment started. All we had to do was get in. We would crank in our checkpoints. Over in Vietnam it was a general kind of thing to get us back if we got disoriented on a spin or something. A lot of that [missions over North Vietnam] was visual navigation by the pilot. I had to keep track of it because I had to know when to turn my equipment on and off and again know what was going on back there because of the controls that I had.

"We would have the targets in the co-ordinates and he [the pilot] would have a needle presentation. You've got the heading needle and the distance-to-go needles and as [we] got closer, he had to keep the heading needle between the two distance-to-go needles. When they closed, that meant you were on target. If the needles closed, and his was over here [off to the side], that meant you weren't on target. So my information was feeding him.

"I would trigger the cameras before then [reaching the target] ... we used to do it a minute before. ...[We'd also] pick-up all the electronic transmissions in the area; all the radar signals. We could tell whether it was a search radar or a missile radar. ... You had three or four radars you were working with. They all had different sounds. The more accurate the radar, the faster the [tone] goes and your blood starts pumping.

"[After recovery] the [electronics] people would run out there and take all the packets out. They'd have people pulling film out and people pulling tapes out. ... All our information had the co-ordinates, air speed, altitude, everything they needed. They could just put it in there [the IOIC] and run it through their machine."

In conducting their photo-reconnaissance runs against target areas, the RA-5Cs would also cover the surrounding areas with their panoramic cameras and pick up anything

they could with their varied sensory equipment. In so doing, they literally saturated the intelligence personnel on the carrier with data. As an example, during the squadron's 1972-1973 WestPac cruise in USS *America* (CVA-66), RVAH-6 aircraft produced 563,422 ft (171731 m) of film for input into the IOIC.

"Our apprehension rises as we head north to ... deadly North Vietnam," a naval aviator recorded in his diary in 1965. "These [missions] against N Vietnam are for keeps – flack [sic], automatic weapons, SAM-2s, MiGs, weather and the people; all hate America."

During the period 1964-1973, the most heavily defended skies in the world were those over North Vietnam. Although there was a definite airborne threat in the form of MiG aircraft, the biggest danger to combat pilots was ground defences. A mixture of various calibre anti-aircraft guns – 23-mm, 37-mm, 57-mm, 85-mm and 100-mm – could be found all over the country, concentrated particularly around places like Hanoi and Haiphong. In 1965 photo-reconnaissance detected the presence of Soviet-supplied surface-to-air missiles (SAMs). Likened to telephone poles by pilots who dodged them in Southeast Asia, the missiles were capped by a 350-lb (158-kg) warhead and rocketed through the air at Mach 2. Guided by a tracking radar that homed in on the target, they could reach altitudes of nearly 60,000 ft (18288 m), and if one exploded within 200 ft (60 m) of an aircraft, it was going down. By 1967, some 200 SAM sites were scattered throughout North Vietnam.

As mentioned above, the lives of those who flew photo-reconnaissance missions were particularly dangerous in that their appearance over a given site was predictable, and when they arrived they and their fighter escort were literally the only game in town in the way of targets. In pre-flight

BuNo. 156621 (also seen in the view of RVAH-9 aircraft at the top of the page) takes fuel from a KA-6D while another CVW-9 aircraft (an F-4J of VF-96) awaits a 'top up' during the 'Hoot Owls' penultimate cruise, in* Constellation *in 1974.

RVAH-5 and RVAH-9 were disestablished on the same day – 30 September 1977. The 'Hoot Owls' last cruise, during 1976/77, was the first by a Vigilante squadron aboard the then-recently commissioned USS* Nimitz *(top left). Post-Vietnam, RVAH-9 operated a mixture of RA-5Cs, including examples converted from A-5A standard like BuNo. 149299 (above) upgraded with J79-GE-10 engines and seen over Key West in 1977.

Below: 'NE'-coded for 'Savage Sons' final carrier deployment, BuNo. 156608 was photographed at NAS Jacksonville in October 1976. '608 went on to serve with RVAH-3 and, finally, RVAH-7, where it become the last operational Vigilante of all.

***1978, the Vigilante's second-last year of operations, saw the demise of a single Vigilante unit, RVAH-6 'Fleurs' disestablishing on 20 October. Photographed in August, the unit's last three operational aircraft formate at the conclusion of their last cruise, to the Mediterranean in USS* Nimitz.**

During 1975 RVAH-6 made a WestPac deployment in* Kitty Hawk. *As deck crew look on, BuNo. 156625 'NH/603' looks set to 'snag' the first arrestor wire as it touches-down on CV-63's deck.

planning, RA-5C pilots and RANs, armed with the known location of anti-aircraft batteries and SAM sites, outlined their flights in hopes of avoiding as much ground fire as possible. However, as one officer remembered, "sometimes you couldn't [locate all the sites] and you just had to pay your money and take your chance."

The Vigilante's greatest attribute when it came to countering enemy fire was its speed. On each reconnaissance mission, the RA-5C was usually accompanied by a fighter escort consisting of an F-4 Phantom II carrying wing fuel tanks and missiles. Such was the speed of the Vigilante that one pilot recalled that "[we] would flat outrun them unless the fighter guys knew the route and really played the turns. We were frequently accused of using max afterburner because they couldn't keep up when we stayed in min[imum]." However, there was a method to a Vigilante pilot's madness when it came to his afterburner selection. "Normally when you went in over the beach, you put your engines in mid-burner [to] get the soot signature off," commented one RA-5C driver. "Your engines laid kind of a black track behind the aircraft, unburned oil or fuel. And the way to knock that track off was to go into mid-burner. When you went into mid-burner, the poor old F-4 had to really put the power on because he was carrying a large centreline tank. If you had a long mission over the land, you'd run them out of fuel. They would position the tankers very close to where we were coming out over the water."

As the mission progressed, it was certainly in the best interest of the pilot to keep the F-4 in close proximity. Aft visibility from the pilot's cockpit of the aircraft was not the best, and the frontseater could expect no help from the RAN, who was buttoned up in a veritable hole with only tiny windows on the outside world. Therefore, if AAA began to get too close, the F-4 was the saving grace for the photo-reconnaissance aircraft. "In the Vigilante we had a 120° blind spot. We couldn't tell what was behind us as part of radar pick-ups [and] SAMs, so we always had [a] Phantom with us and [he] would stay behind us and move around and let us know if we were getting into trouble. If the AAA was firing, [he'd] just tell us when it was getting too close to our tail and tell us to break right or break left."

Combat losses

Of all the known combat losses over Vietnam, 77 per cent of them were the result of anti-aircraft fire. Although the SAMs captured the imagination as they streaked through the sky with their warbled tracking tones ringing in a pilot's earphones, it was flak and sometimes unseen rounds that brought down most aircraft. The experience of Vigilante crews mirrored this statistic. Of the 18 RA-5Cs lost over North and South Vietnam, 13 were the victims of AAA, two fell to SAMs, a MiG shot down one, and two were lost to unknown causes. "Normally we had a pretty good idea where the SAMs were," a former RVAH-11 pilot recalled. "I only saw SAMs two or three times, but they picked me up on their radar many times. … I think the only times missiles were anywhere close to me was when we were doing bomb assessment on a target. The best way to avoid missiles was to not go where they were firing them, obviously. You could be extremely low and avoid missiles, but if you were extremely low, of course, you had everybody and his brother with a machine-gun or rifle or 37-mm working you over. So you had to figure out where you wanted to be, where the least threat was, and plan your flight accordingly."

When SAMs were fired, they usually rocketed skyward in pairs under the theory that while the pilot was dodging one he had to necessarily pay less attention to the other, increasing the likelihood that it would strike home. In its ability to outmanoeuvre SAMs, the RA-5C received mixed reviews, with some pilots asserting that its ability to pull *g* was limited. However, one former squadron commander asserted that the aircraft "outmanoeuvred the SAM time and again" over

Its tail lit up by J79s in full afterburner, BuNo. 156610 is prepared for a 'cat shot' from the deck of* Nimitz, *during the final cruise of 1977/78.

RVAH-1 'Smokin' Tigers' disestablished on 19 January 1979, though it had effectively ceased operations on 30 October 1978, the day the unit returned from its last cruise, to WestPac in Enterprise. BuNo. 156627 was photographed in March 1978, immediately prior to the final carrier deployment.

North Vietnam and put forth as proof the fact that his squadron had completed 125 missions over Hanoi and Haiphong with only two instances of battle damage.

Of the 18 RA-5Cs lost to enemy fire over Vietnam, six were flown by squadrons operating from the flight deck of USS *Kitty Hawk* (CVA-63), and the stories of some of them dramatically illustrate the experience of ejecting from an aircraft in combat.

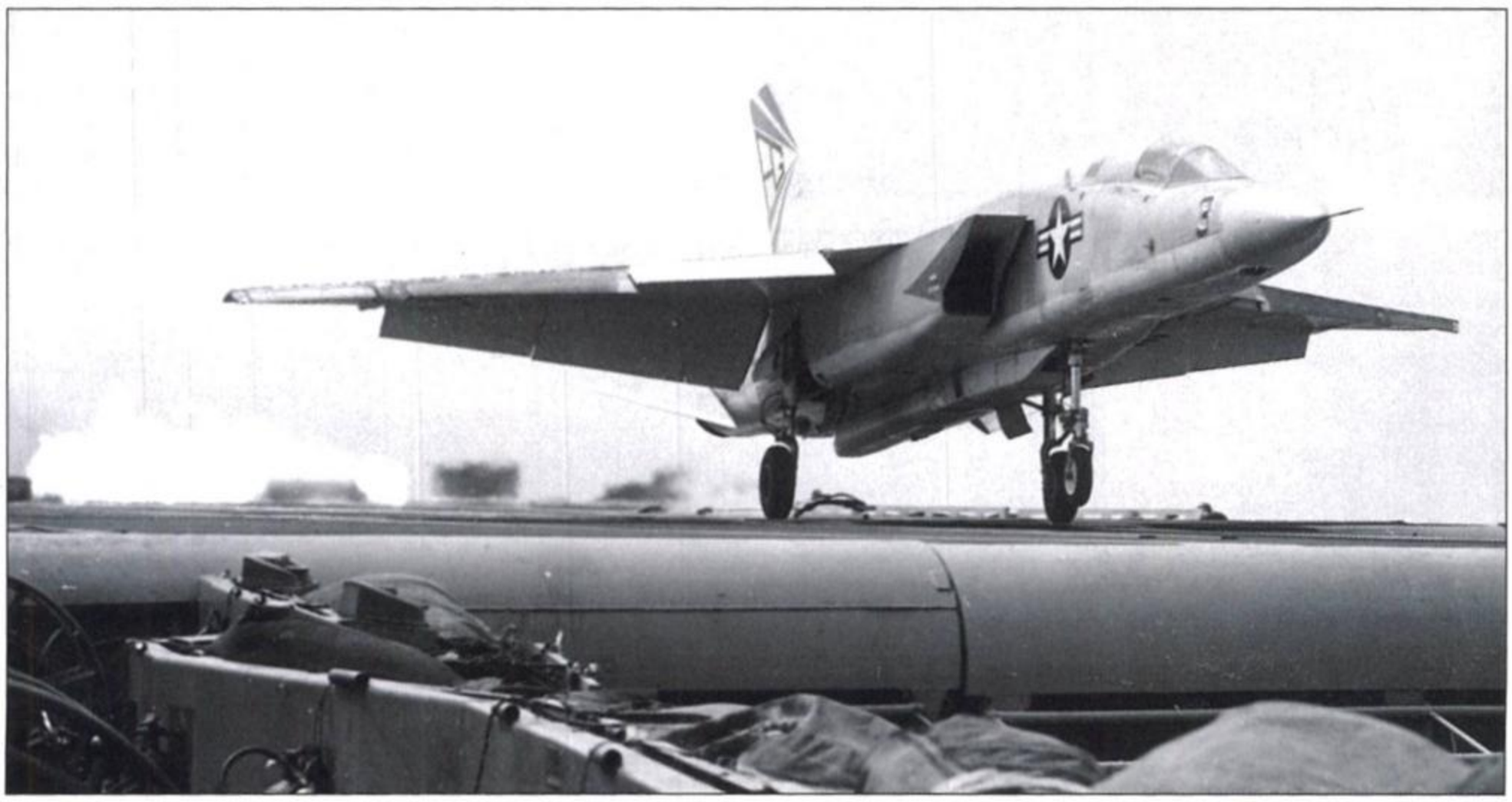
A veteran of photo-reconnaissance missions during the Cuban Missile Crisis, Lieutenant Gerald L. Coffee felt "the adrenal glands pumping a little bit more than usual" as he taxied his RA-5C onto the catapult aboard *Kitty Hawk*. Although he had seen the menacing black puffs of enemy flak on previous flights, it had not threatened his aircraft. However, on this crystal clear day, 3 February 1966, he was heading up north.

"The mission went like clockwork. Since there was hardly any cloud cover over the lower half of North Vietnam, I bracketed the husky steel and concrete bridge the way I had taught many others as a recce training instructor in Florida. The actual targets for the attack boys were less distinct, but I had flown the line and was sure of the coverage from my panoramic horizon-to-horizon camera. Although I had seen no flak, I jinked frequently during the entire time I was over land, changing directions slightly with high-*g* turns often enough to keep any gunners from tracking me. Then heading back toward the coast, with my F-4 Phantom II fighter escort spewing black smoke as he tried to catch up, I felt it. WHUMP! A hit!"

An unseen anti-aircraft projectile had hit somewhere in the aft section of the aircraft, and in moments the hydraulic warning lights blinked red. Putting the aircraft into afterburner in order to get the most speed out of it, Coffee hoped it was enough to get him over the waters of the Tonkin Gulf, where the odds for being rescued dramatically improved. However, it was not to be.

"The vibration became heavier and the control stick sluggish. Still accelerating, the plane suddenly rolled to the left. Control stick stiff – no effect. Jammed right rudder pedal. Left roll stopped but then immediate right roll." Coffee triggered the emergency generator and wind-driven hydraulic pump to no avail. The hit had severed the hydraulic lines. The lifeblood of his aircraft, the precious hydraulic fluid that allowed him to control it, was gone. "Nothing! No control! Sky-land-sky-land-ocean. The nose dropped now, and we picked up more speed. 'Mayday! Mayday! Mayday!' Rolling rapidly! Speed 680! Red lights flashing! No more sky ahead, only the shimmering blue gulf spinning in front like a propeller. … Eject, Bob [RAN, Lieutenant (junior grade) Robert Hanson]! Eject! Eject! Eject!"

After a furious pursuit by the North Vietnamese, a badly injured and exhausted Gerald L. Coffee was captured. His RAN, Robert Hanson, successfully ejected from the aircraft, but was apparently killed by his captors.



Fuel tank conflagrations

It was not unknown for Vigilantes to lose their linear bay fuel tanks during a 'cat shot', all three fuel cells landing unceremoniously on the flight deck. An explosion and fire on the deck would usually result though, more often than not, damage to the ship was minor and experienced pilots were able to continue their take-offs normally, as in this example, where Cdr John H. Huber of RVAH-12 lost his fuel cells, and the 885 US gal (3350 litres) of fuel they contained, aboard USS *Independence* on 4 September 1969. Others were not so lucky, including the crew of BuNo. 156609 from the same unit which, during spring 1973, lost one fuel tank and caught fire during a 'cat shot'. The crew ejected as the aircraft rolled out of control; both survived.

Project Snare

Utilising a pair of Vigilantes from RVAH-12 (BuNos 148933 and 151727), Project Snare involved the evaluation of an infra-red spectrum sensor for the gathering of emissions from Soviet bombers shadowing *Independence*'s carrier battle group in the Mediterranean in 1971/72. Both aircraft are seen in leading and trailing positions of this formation, the sensor being fitted in a fairing on the starboard side of the aircraft's spine, forward of the vertical tail. Few photographs of these aircraft would appear to have been released and their use after the 1971/72 cruise appears unlikely. Unusually, BuNo. 151727 was stricken at NAS Rota, Spain in January 1972.

On 18 May 1968, Commander Charlie James and Lieutenant Commander V. D. Monroe of RVAH-11 launched from *Kitty Hawk* for a reconnaissance mission along the 19th parallel. "We were making a flight line right down the 19th Parallel. That's when the President, LBJ [Lyndon Baines Johnson], had said that we're not going to operate anywhere above the 19th Parallel. Of course, the North Vietnamese moved all of their guns down south of the 19th Parallel. … The day before that mission I got shot down on, I saw more flak than I'd ever seen out there. In fact, I'd almost compare it with a raid [I went on] to Pyongyang in Korea. That was almost black with flak there. When I planned the mission I knew it was a bad place to go and I said, 'You know, you're putting me right over the Russian artillery school there and those guys are pretty good.'

"Anyway, I went on the mission and the weather got real bad, so I was forced down to stay out of the thunderstorms and try to get a picture. It probably would have been prudent to turn around and go back home, but I continued on and got hit, probably by 58- or 90-mm anti-aircraft fire. It was right about over the Russian artillery school. They put about seven off my left wing tip and as I was making some violent manoeuvres, I got a direct hit. We were immediately on fire and I think the [RAN] was killed when we got hit because flames shot up in my cockpit and it had to come from his cockpit to get up there. The escort said, 'You're on fire!' And I said, 'I know!' About that time I lost my hydraulics, so I pulled the ejection curtain.

"Normally, people would get their wrists burned or their face burned. We had a fix in the seat to replace all the aluminium firing channels with stainless steel because the aluminium would erode when you ejected and consequently you'd get burned. We hadn't changed it. I remember there was really a high, eerie squeal and I think it was the strap on the side of my hardhat vibrating. I was just about transonic at the time – probably 550 kt [or] something like that. I don't remember being pumped out of the seat. The first thing I remember is [that] I was conscious, but I couldn't see. I was blind. I reached up and felt the risers and I knew I was in a parachute because I could kind of feel

Above: RVAH-12, the first of the two RECATKRONs established specifically to operate the RA-5C, undertook its last cruise in 1978/79, aboard Saratoga in the Mediterranean, disestablishment following in July 1979.

Right: Allocated to CVW-3 for the final cruise, the 'Speartips' aircraft carried 'AC' tailcodes. Here BuNo. 156640 refuels from a VA-75 KA-6D from the same wing.

'Sea Dragons' bow out

As the need for Vigilante aircrew, as well as IOIC and maintenance personnel, receded as the RVAH community got smaller by the year, so the need for a training facility was reduced. By 1976, RVAH-3 was turning out just 20 aircrew – nine pilots and 11 RANs (compared with 98 aircrew graduates in the three years from 1965 to 1968). Disestablishment came on 17 August 1979, after 18 years as the Vigilante RAG and a few weeks before the last operational squadron and the last operational RA-5C Vigilantes were finally retired.

myself floating. I passed out again and I didn't wake up until I was on the ground. I'd probably been [dragged] through the rice paddies for I don't know how long because when I went to release the fittings on the parachute, there wasn't any skin on the back of my hands. Both hands were just raw meat. And then I passed out again and the next time I woke up I was in my underwear. They had me."

Of the 36 pilots and RANs shot down during the Vietnam War, rescue helicopters recovered only nine, the remainder being either captured, killed or listed as missing. One of those fortunate enough to be pulled from the jaws of captivity was Lieutenant (junior grade) Francis S. Prendergast, a member of RVAH-13 from *Kitty Hawk*, whose tale of survival was legend among those who flew in the 'Tonkin Gulf Yacht Club'.

While flying a coastal reconnaissance mission off North Vietnam on 9 March 1967, Prendergast and his pilot, Commander C. L. Putnam, were hit by automatic weapons fire. Their RA-5C, which was travelling at 450 kt (830 km/h) at an altitude of 350 ft (107 m), was almost immediately engulfed in flames and pitched up before both crewmen successfully ejected from the aircraft. The Vigilante was operating just one-quarter of a mile (400 m) off the coast, and the young RAN landed on the beach; he proceeded to make his way into the water to distance himself from the enemy. However, he was quickly surrounded by local militiamen in knee-deep water, and to the crew of the approaching rescue helicopter and the RESCAP (Rescue Combat Air Patrol) pilots, captivity seemed certain.

However, no one could envision Prendergast's preparation and quick wits. In addition to the standard 0.38-in calibre revolver carried in a shoulder holster by all aircrewmen, he packed extra protection in the event he was shot down, namely a 0.22-in calibre automatic inside his flight suit. For safety reasons, he left the first two chambers of the .38 empty, and when one of the North Vietnamese seized his revolver and pointed it at him, he knew he had a window of opportunity if the occasion arose to make an escape. It came when F-8 Crusaders and A-1 Skyraiders of the RESCAP roared overhead and began strafing the beach, driving the gathered crowd of North Vietnamese under cover. Knowing that the aircraft would not strafe near their own man, two militiamen remained with the American, one pointing a rifle at him and the other covering him with the .38.

With his would be captors distracted by the low-flying aircraft, Prendergast quickly unzipped his flight suit, chambered a round in the .22, and shot the enemy rifleman in the head. Naturally, the gunshot caught the attention of his partner, who immediately squeezed the trigger on the .38, only to find the click of a hammer hitting an empty chamber. A second shot from the .22 put him down and allowed the young RAN to swim out to sea, where the rescue helicopter quickly plucked him from the water and delivered him to safety.

Vietnam sidelights

A number of events and factors had a direct impact on the combat missions logged by Vigilante crews over Vietnam. In December 1964, Rear Admiral Robert Goldthwaite wrote to Vice Admiral John S. Thach regarding the support provided to the new reconnaissance attack

On the flight line at Key West on 26 September 1978 were four Vigilantes, including BuNo. 156625. At this point RVAH-3 was less than a year from disestablishment and a revised marking had been adopted, incorporating a lightning bolt design on the tailfin and nose.

Top: BuNo. 156608 was photographed on a training mission from NAS Key West in November 1977.

Below: Seen in early 1979, both of these 'Sea Dragons' aircraft had been stored by June.

Two views of RVAH-3 aircraft during the final months of the squadron's existence show BuNo. 156608 on finals at Key West in November 1977 (top) and BuNo. 156620 over Florida in June 1978. When the end finally came, a number of Vigilantes were stored at Key West prior to their sale to a scrap yard. Consideration was briefly given to converting selected Vigilante airframes as target drones, but this came to nought.

community, stating, "The road is not smooth and the material and operational support have presented us with many perplexing problems." The admiral quoted from a letter received from a fleet squadron highlighting this dilemma. "I am now becoming accustomed to the lack of real interest in this programme," the officer wrote. "In fact, I am becoming weary of teaching non-believers, indoctrinating the curious, and particularly of countering the opinions of those who – through ignorance, stupidity and the inability to appreciate the massive progress made so far – consider the system to be a modern day Moby Dick."

Although the issue of proper installations of equipment gradually receded as the RA-5C became more fully integrated into the fleet, the overall issue of maintenance on the aircraft continued. Without a doubt, the Vigilante was a complex piece of machinery, and with the influx of new equipment required by the reconnaissance mission, the aircraft sometimes proved a bear to maintain. As noted historians Norman Polmar and Peter Mersky wrote in their book *The Naval Air War in Vietnam*, the RA-5C was the best tactical photo-reconnaissance aircraft in the Navy when it worked properly, but the exacting standards of its equipment made it temperamental.

Recalled one maintenance officer, "They were a real headache. … The electronics part was where it was really a bear. It took many, many hours. That was the down feature of the Vigilante, the high maintenance hours per flight hour. … With three planes we did not have the opportunity to have a 'hangar queen' that we could steal parts from." Official and unofficial sources tell the tale of the aircraft's maintenance woes. One squadron's action report from a Vietnam War cruise reveals that of the 752 scheduled missions, 123 had to be cancelled because of maintenance. In addition, during one cruise RVAH-3 produced a humorous fake advertisement for the 'RA-5C Vigilantoy', which mocked the aircraft's capabilities and concluded: "You can't afford to buy less than a dozen – that way you can always have one to play with while the others are being repaired."

Changes at home

In addition to the mechanical dimensions of the aircraft's operations, the human element changed during the course of the Vietnam War. In 1968, after high-level debate that included relocating the RVAH squadrons to an Air Force base, NAS Sanford was closed and all reconnaissance attack aviation elements moved to their new home, NAS Albany, Georgia. By 1970 Reconnaissance Attack Wing One at the base encompassed some 325 officers and 3,000 enlisted men, including the wing staff, nine operational fleet squadrons, one training squadron, a photo lab, and the Naval Intelligence Processing System Training Facility. The latter programme included 24 separate courses covering the operations of the IOIC, and graduated about 350 trainees per year. For flight personnel, both pilots and RANs, training encompassed 26 and 32 weeks, respectively, in RVAH-3. This time included 600 hours of ground training and 110 hours of flight time.

Traditionally, the pilots assigned to the heavy attack programme were experienced aviators, and this practice continued in the RA-5C programme. However, when Captain Ken Enney assumed command of the wing, he seized upon the idea of introducing newly-winged aviators into the Vigilante pipeline. "I could see that the rank structure in the squadrons was very top heavy. Of course, the aircraft had a bad reputation. I'm not really sure why it had a bad reputation. I think a lot of people who flew it wanted people to think it was a real bear to bring aboard and what not. I went up to see DCNO for Air [Deputy Chief of Naval Operations for Air] and said that I wanted to bring some young blood into the squadrons. I wanted to pick them right out of the training command. I brought five young guys who were in the top of their classes going through flight training … into the programme. They all did very well, which sort of helped take away the reputation that it was such a beast." The first of the five, Lieutenant (junior grade) Dave Jones, completed his familiarisation in the RA-5C in April 1970, and commenced training. Vigilante squadrons were soon

Below: RVAH-7 personnel mark 8,000 accident free flying hours around the time of their penultimate carrier deployment, aboard Kitty Hawk *in 1977/78.*

receiving their first true 'nuggets'.

During the Vietnam War, eight RA-5C squadrons logged a total of 32 deployments to the Tonkin Gulf. Though no longer flying in hostile skies after 1973, the Vigilante remained an integral part of carrier air wings in the Mediterranean and western Pacific for the remainder of the 1970s. Shifting to their final home base, NAS Key West, Florida, in 1974, the aircraft operated from decks that had become familiar in Vietnam, and also logged traps onboard the Navy's second nuclear-powered carrier, USS *Nimitz* (CVN-68), on Mediterranean cruises during the period 1976-1978.

Final cruise

The experience of RVAH-7 on its final cruise demonstrates that the aircraft's capabilities were in demand, even in peacetime. During exercises in Hawaii and the Philippines, squadron aircraft staged mock pre-strike reconnaissance runs and provided accurate photographs of a landing beach for use in an amphibious assault exercise. In addition, during a mining exercise, an RA-5C tailed the drop aircraft, pinpointing the position of the mines by utilising the forward oblique and panoramic cameras and comparing the splashes from the mines with the surrounding terrain. At sea, an RA-5C operated in conjunction with an E-2B Hawkeye in obtaining photographic and electronic coverage of a Soviet 'Mayak'-class intelligence ship.

Yet, even while the aircraft continued to deploy, the sun began to set on the Vigilante. On 1 May 1974, RVAH-14 became the first RA-5C squadron disestablished, and the following year RVAH-11, the first Vigilante outfit to receive the coveted Presidential Unit Citation for action over Vietnam, also passed into history. In the ensuing years, others followed, and by September 1979 only RVAH-7, ironically the first squadron to deploy with the Vigilante, remained.

Final curtain

RVAH-7 was finally disestablished on 28 September 1979, shortly after its final cruise (to WestPac in *Ranger*) had been completed, bringing total deployments made by the Vigilante to 73 – 41 to WestPac and the remainder to the Mediterranean. (Four earlier cruises had been completed by the VAH squadrons equipped with A-5As.) Thereafter, all that remained of the Vigilante community was Reconnaissance Attack Wing One, which was in turn formally disestablished on 7 January 1980. The Navy's carrierborne reconnaissance taskings were, from then on, the preserve of the few remaining RF-8Gs and, from 1981, F-14A Tomcats equipped to carry the TARPS pod.

BuNo. 156641 is seen against a volcanic backdrop in the Philippine Islands on 7 May 1979, during the last Vigilante cruise.

Below: This well known view was one of a number showing BuNo. 156608 during RVAH-7's last cruise. After retirement, '608 was made a gate guard at NAS Memphis, TN.

On 17 August 1979 (the very day that the RAG, RVAH-3, was disestablished), BuNo. 156615 (below), crewed by LCdr Habel and Lt Parr, made the last carrier trap by a Vigilante, aboard USS* Ranger. *RA-5C BuNo. 156608 (above) then made the last catapulted carrier launch, when Cdr Myers and LCdr McManamon left* Ranger *for NAS Key West on 21 September. The same aircraft was to make the last field arrested landing (crewed by Lt Little and LCdr McCray) at Key West on 14 November and the last Vigilante flight of all on the 20th, when Lt Westmoreland and LCdr Plunkett (the latter from CRAW-1) departed Key West for Davis-Monthan AFB.

On 21 September 1979, BuNo. 156608 bid farewell to the fleet as it was catapulted off USS *Ranger* (CV-61), the same carrier that had taken the first RA-5Cs to war in 1964-1965. Never again would the sleek aircraft slam into the arresting wires or roar off the deck in a cloud of steam. Nearly two months later, on 20 November 1979, RA-5C (BuNo. 156608) touched down at Davis-Monthan Air Force Base, Arizona, where row upon row of tired warbirds were positioned in their final formation, the roar of their engines long silenced. The screech of its tyres on the runway marked the end of the last flight of a US Navy Vigilante.

In 1981 the RF-8 Crusader completed its final active deployment aboard a US Navy carrier. Coupled with the earlier retirements of the RA-3 Skywarrior and the RA-5C Vigilante, this left the Navy without a designated reconnaissance aircraft. Instead, the service turned to the F-14 Tomcat fighter to fill the void, equipping some of them with the Tactical Air Reconnaissance Pod System (TARPS). Housing a forward-vertical oblique camera, horizon-to-horizon camera, IR reconnaissance sensor and associated electronic/environmental equipment, TARPS was designed to be carried externally beneath the Tomcat's fuselage. Eventually, three TARPS-equipped F-14s were assigned to each carrier air wing.

Vigilante vindication

The shift away from a dedicated tactical reconnaissance aircraft like the RA-5C represented the Navy's commitment to minimising the number of aircraft on a carrier deck by taking advantage of multi-mission capability. However, for those who had devoted their careers to 'Tac Air Recce', TARPS was a step down in capability. "Where the RA-5C and RF-8 are no more, TARPS will give us a reconnaissance capability that is at best on a par with what we had prior to the Korean War," the Commander of Reconnaissance Attack Wing One wrote in May 1979. "Without a dedicated reconnaissance community, TARPS, as a secondary mission in a VF [fighter] squadron, will be lucky to come out ... knowing how to spell reconnaissance."

Although the above officer may have been overstating the case a bit, the Persian Gulf War in 1991 revealed the

Below right: BuNo. 151629 was one of the luckier RA-5Cs to enter 'The Boneyard'. Purchased in 1987, it today resides in the International B-24 Memorial Museum at Pueblo Memorial Airport, Colorado.

Below: In this 1980 view, an apparently redundant ex-RVAH-3 Vigilante shares some long grass with an equally dishevelled A-3 at NAS Lakehurst, where the RA-5C had been in use by the Naval Air Engineering Center.

Boneyard and beyond

While no A-5As were retired there, 36 RA-5Cs finished up at the Military Aircraft Storage & Disposition Center (MASDC, renamed Aerospace Maintenance & Regeneration Center – AMARC – in 1985) at Davis-Monthan AFB, Arizona. The first to arrive was BuNo. 150838 from the NATC on 10 July 1970. Another 31 airframes followed between 1970 and 1974 (including the first prototype, BuNo. 145157, from RVAH-3), the first disposals taking place in 1978, when a number of Vigilantes were sold to the New Mexico Institute of Mining and Technology (later known as New Mexico Tech) at Socorro. New Mexico Tech employs surplus aircraft for the testing of ballistics, projectiles and aircraft metals research, funded by the US government. In 1979 a further five aircraft were passed to the Naval Weapons Center at China Lake, California and the following year a single example (BuNo. 149289) was made available to the nearby Pima Air Museum. With the retirement of the Vigilante in 1979, four more aircraft arrived from RVAH-3, these being the last additions to the MASDC inventory. In April 1986 the surviving 20 airframes were transferred to the USAF inventory in preparation for their shipping, between May and July, to Tolicha Peak, Nevada for use as range targets. Sadly, BuNo. 145157 was among these aircraft.

North American's unsuccessful RAAF proposal was based on the RA-5C. In model form, at least, it appears to have been capable of delivering Bullpup ASMs as well as iron bombs while retaining the ventral sensor canoe.

Export proposals, 'Retaliator' and NR-349

To fill a requirement for a replacement for its aging English Electric Canberras, the Royal Australian Air Force evaluated the McDonnell Douglas F-4 Phantom, BAC TSR.2, Dassault Mirage IV and the North American A-5 before, in October 1963, placing an order for 18 General Dynamics F-111As and six RF-111As (later amended to comprise 24 F-111Cs). Britain, too, looked at purchasing a batch of Vigilantes for its projected CVA-01 aircraft-carrier, which had been designed with both the RA-5C and Grumman E-2 Hawkeye in mind. However, the notorious Defence White Paper of 1966 put paid to the continued existence of the Royal Navy's conventional aircraft-carrier force and there the matter ended.

NAA's Columbus Division made numerous representations to the USAF attempting to interest the service in Vigilante derivatives. In 1960 the most likely operator appeared to be Air Defense Command (ADC) and most NAA proposals were intended to meet the ADC's requirements. 'Retaliator' was the most promising of these, incorporating a single Rocketdyne (North American) XLR46-NA-2 liquid-fuel rocket fitted in the space formerly occupied by the linear weapons bay. This was intended to improve speed and altitude performance and also allowed the carriage of a number of air-to-air missiles. Though it was shelved, the concept was revived 10 years later as part of bid to satisfy the Improved Manned Interceptor (IMI) requirement for an aircraft to replace ADC's existing F-101, F-102 and F-106 aircraft. In place of the rocket engine NR-349, as the new design was known, sported a third GE J79 powerplant, positioned above and between the existing turbojets and fed by bifurcated intakes faired into the upper surfaces of the fuselage; it was to be armed with radar-guided air-to-air missiles. NR-349 did not leave the drawing board.

Plans for the US Marine Corps to purchase Vigilantes for use from shore bases in the Western Pacific (using portable SATS short field equipment) were defeated by funding constraints.

shortcomings of TARPS when compared to aircraft like the RA-5C and RF-8. TARPS-equipped F-14s were reliable – they maintained an 88 per cent mission completion rate – but they were simply too few in numbers. Rear Admiral Thomas Brooks, the Director of Naval Intelligence during Operation Desert Storm, stated that "we had better tactical intelligence support available in Vietnam than [Vice Admiral] Stan Arthur [overall commander of naval forces during the Gulf War] had available to him in the Gulf War."

Had the Vigilante never been modified for the reconnaissance-attack role, it would probably be considered a design anomaly, an aircraft ahead of its time that, due to circumstances, served only briefly. However, it is a tribute to the design's inherent versatility and capability that the Navy was able to take an aircraft intended to be the premier carrier-based nuclear bomber and transform it into perhaps the service's premier reconnaissance platform. In so doing, the Vigilante achieved a lasting legacy in America's longest air war.

Aside from its capabilities, the mere physical appearance of the aircraft added to its reputation. Its size and speed were simply awesome. In addition, whether at rest – it "just looked like it was going Mach 1 when it was sitting there," in the words of one aviator – or in the air, few could deny it a place as one of the most aesthetically pleasing aircraft ever to come off a drawing board. At a cocktail party, when the wife of a Vigilante pilot commented on the beauty of the aircraft to North American Aviation President Will Yahn, he responded "If we could have sold them on their looks, we could have sold them [the Navy] a million of them."

In short, whether those who manned its cockpits or those who had the opportunity to see one fly, the Vigilante was an aircraft to remember. **M. Hill Goodspeed**

These artist's impressions of NR-349 give some idea of what NAA had in mind for Air Defense Command. Each NR-349 is armed with six long-range AAMs, of a size comparable to AIM-47 Falcon (as proposed for the Lockheed YF-12). In the lower artwork note the 'AWACS' aircraft, with eight engines as originally proposed.

Vigilante Operators

United States Navy

The number of Vigilantes assigned to each squadron was largely determined by the scarcity of the aircraft throughout its career. The nine operational squadrons were initially assigned six aircraft each, this allocation remaining fixed until around 1971, when attrition began to take its toll on those aircraft held in reserve and production was restarted. From then on unit establishment stabilised at four or five machines, but by 1973 it had dropped to just three – a figure that remained fairly constant until the type's retirement. Had the number of Vigilante units not been reduced from 1974, this figure may well have dropped further. Here the 10 Vigilante squadrons and the principal second-line users of the type are detailed and carrier deployments listed. Note that two-letter 'shore codes' were rarely used by some units.

VAH-1/RVAH-1 'Smokin' Tigers'

Like many of the Vigilante squadrons, RVAH-1 was a redesignated VAH squadron and therefore continued the legacy of that programme. VAH-1 was established on 1 November 1955 under the command of Commander Paul F. Stevens, a highly decorated patrol-bomber pilot during World War II. On 31 March 1956, the squadron received five A3D-1 Skywarriors, thereby becoming the first fleet unit to take delivery of the jet-powered nuclear bomber. The squadron's initial deployments were to the Mediterranean and North Sea area onboard USS *Forrestal* (CVA-59) and USS *Independence* (CVA-62). Following their return from their April-August 1962 cruise, the 'Tigers' began transitioning to the A-5A Vigilante. On 22 January 1963, the first A-5A was accepted for service by the squadron at NAS Sanford, Florida and in March of that year VAH-1 became the first squadron to win a monthly bombing stream while flying the A-5A. The squadron also completed one deployment with the heavy attack version of the Vigilante in *Independence* during August 1963-March 1964, participating in several NATO and Sixth Fleet exercises. Upon returning to Sanford, VAH-1 began transitioning to the RA-5C, with squadron skipper Commander J. W. Taft delivering the first example from the North American plant at Columbus on 10 July 1964. On 1 September 1964, the squadron was redesignated RVAH-1. The 'Smokin' Tigers' logged their first combat deployment to Southeast Asia during May-December 1965, completing 308 combat missions. Over the course of the next 13 years, RVAH-1 alternated between the Atlantic and Pacific Fleets, completing three additional combat cruises. Like all RA-5C squadrons, it shifted home ports from Sanford to NAS Albany, Georgia, in 1968, and in 1974 moved to NAS Key West, Florida. The second fleet squadron to operate the Vigilante, RVAH-1 disestablished on 19 January 1979.

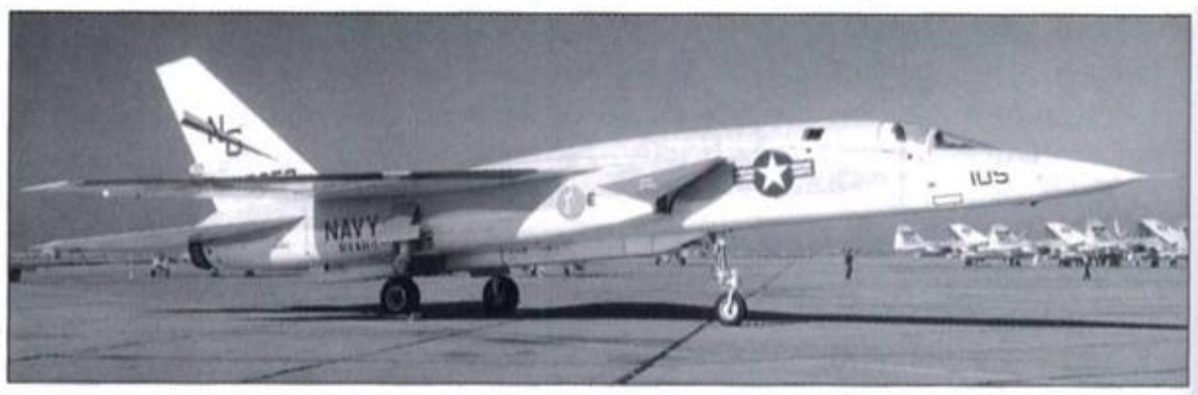
Perhaps the most famous insignia in the VAH/RVAH squadrons was the 'Smokin' Tiger'. Upon assuming command of the squadron in 1955, Commander Paul Stevens initiated a design contest within the ranks in the hope of producing a suitable squadron insignia; none of the entries really impressed the skipper. Fortunately, however, at the time there was a cartoonist convention occurring in Jacksonville, Florida, then VAH-1's homeport. He sent several young bombardier-navigators to the convention with the mission of obtaining an insignia, and they returned with the 'Smokin' Tiger'. The insignia features a tiger with a mischievous grin on his face blowing a cloud of cigar smoke. Given the atomic delivery mission of VAH-1, the latter is in the shape of a mushroom cloud produced by the detonation of a nuclear weapon.

CARRIER DEPLOYMENTS (shore code 'GH')

VAH-1	CVG-7	USS *Independence* (CVA-62)	6 Aug 1963-4 Mar 1964	A-5A 'AG/60x'	Med
RVAH-1	CVW-7	USS *Independence* (CVA-62)	10 May 1965-13 Dec 1965	RA-5C 'AG/60x'	Vietnam
RVAH-1	CVW-7	USS *Independence* (CVA-62)	13 Jun 1966-1 Feb 1967	RA-5C 'AG/60x'	Med
RVAH-1	CVW-9	USS *Enterprise* (CVAN-65)	3 Jan 1968-18 Jul 1968	RA-5C 'NG/10x'	Vietnam
RVAH-1	CVW-3	USS *Saratoga* (CVA-60)	9 July 1969-15 Jan 1970	RA-5C 'AC/60x'	Med
RVAH-1	CVW-2	USS *Ranger* (CVA-61)	27 Oct 1970-17 Jun 1971	RA-5C 'NE/60x'	Vietnam
RVAH-1	CVW-3	USS *Saratoga* (CVA-60)	11 Apr 1972-13 Feb 1973	RA-5C 'AC/60x'	Vietnam
RVAH-1	CVW-8	USS *America* (CVA-66)	3 Jan 1974-3 Aug 1974	RA-5C 'AJ/60x'	Med
RVAH-1	CVW-8	USS *America* (CVA-66)	6 Sep 1974-12 Oct 1974	RA-5C 'AJ/60x'	NATO exercise
RVAH-1	CVW-14	USS *Enterprise* (CVN-65)	30 Jul 1976-28 Mar 1977	RA-5C 'NK/61x'	WestPac
RVAH-1	CVW-14	USS *Enterprise* (CVN-65)	4 Apr 1978-30 Oct 1978	RA-5C 'NK/61x'	WestPac

Above: VAH-1's only carrier deployment took place in 1963/64, the squadron accompanying* Independence *to the Mediterranean.

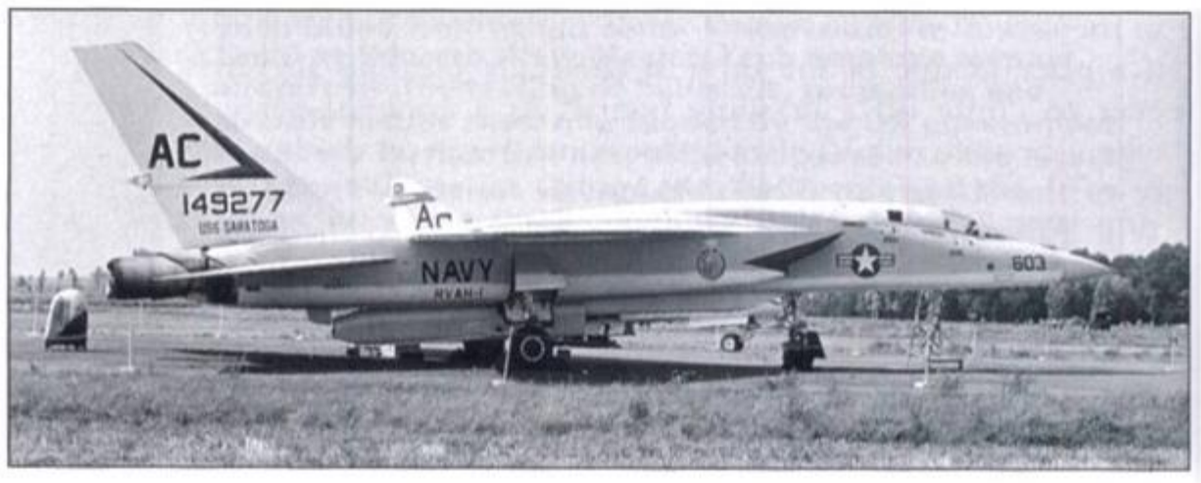
Above: RVAH-1 joined CVW-7 aboard USS* Independence *on two occasions, in 1965 (off Vietnam) and 1966/67 (in the Mediterranean).



***Above: RVAH-1's second Vietnam deployment was in 1968, with Carrier Air Wing 9 in USS* Enterprise.**

Seen in September 1973 prior to a Mediterranean deployment aboard USS* America, *BuNo. 156617 was one of those aircraft constructed when production was restarted in 1968.

One of RVAH-1's RA-5s is seen ashore after the unit's fourth Far Eastern foray.



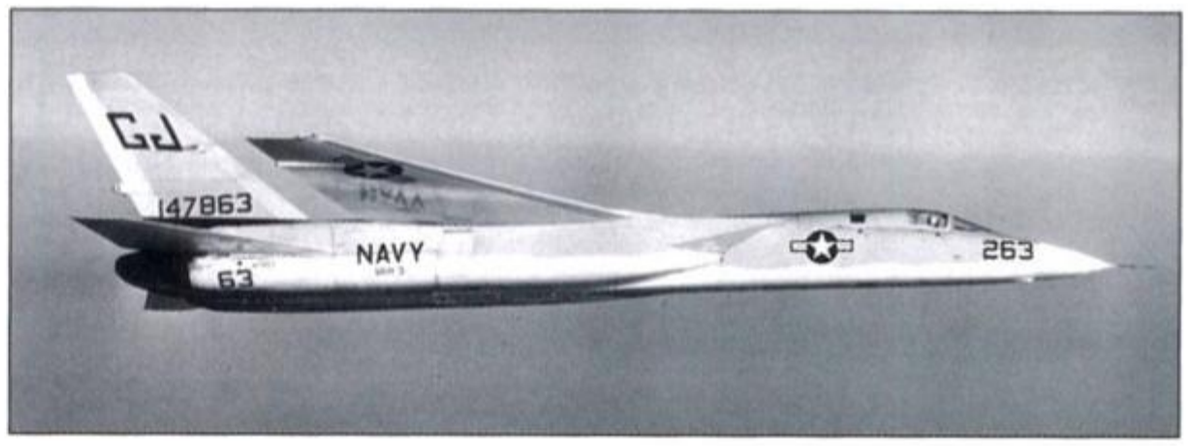
'NK/610' was photographed in 1978, not long before RVAH-1's last WestPac cruise, aboard **Enterprise.**

BuNo. 156617 again, this time apparently still an RVAH-1 aircraft, but also marked as a CVW-1 aircraft from aboard USS **John F. Kennedy.**

VAH-3/RVAH-3 'Sea Dragons'

The first stop for all A-5A/RA-5C crews, VAH-3/RVAH-3 served as the Replacement Air Group (RAG) for the Vigilante, responsible for training all personnel entering the reconnaissance-attack programme. Established on 15 June 1956, the squadron flew A3D-1 Skywarriors in the Mediterranean the following year, becoming the first heavy attack squadron to operate extensively from the deck of a 'Midway'-class carrier. Upon return, the squadron shifted its home base from Jacksonville, Florida, to NAS Sanford, Florida, where it became the Heavy Attack Replacement Training Squadron for the Atlantic Fleet. It continued operating in this role with the introduction of the A-5A Vigilante, revising the curriculum and squadron organisational structure. A total of 18 ground school courses was prepared, totalling some 14,000 instructional hours. On 16 June 1961, the squadron took delivery of the first four A3J-1 aircraft, and by 1962 eight Vigilantes joined a TC-47K Skytrain, TF-9J Panthers, and TA-3B and A-3A Skywarriors on the squadron flight line. During 1963, the squadron received the A-5B and YA-5C aircraft for training, and became the only unit to operate these versions of the Vigilante. On 10 December 1963, the first RA-5Cs arrived in VAH-3, and in the following year the squadron was redesignated RVAH-3. The squadron conducted training flights from three bases during its service, moving from NAS Sanford to NAS Albany, Georgia, on 1 May 1968, and finally shifting to NAS Key West, Florida, on 15 January 1974. As a point of comparison, during the period spring 1965 through spring 1968, 48 pilots and 50 reconnaissance attack navigators completed training in RVAH-3; by 1976, with the RA-5C on the brink of retirement, only nine pilots and 11 reconnaissance attack navigators completed the training syllabus. The squadron was also responsible for the training of personnel in the operation of the Integrated Operational Intelligence Center (IOIC) through the Naval Intelligence Processing System Training Facility, which operated at NAS Albany and NAS Key West. In addition, maintenance personnel received training in RVAH-3. The squadron was disestablished at NAS Key West on 17 August 1979.

RVAH-3's insignia was chosen from entries as part of a squadron contest, and originally produced by a commercial artist in Jacksonville, Florida. It features a dragon emerging from the deep off the bow of a US Navy attack aircraft-carrier, belching forth the fiery mushroom cloud of an atomic weapon's blast. Though the nuclear attack reference in the insignia became outdated when the squadron began training in the RA-5C, the insignia was retained.



Above: One of the first A3J-1s delivered to VAH-3 is seen during a training sortie from NAS Sanford.

Above: The multi-coloured bands on the tail of this RA-5C and its '300' Modex number indicate that it was the mount of RVAH-3's commanding officer.

Above: Seen at the Jacksonville NARF in 1974, BuNo. 156641 sports twin red bands on its tail – a common marking on the RAG's Vigilantes.

Above: Displaying a later version of the red tail striping found on RVAH-3 Vigilantes, this aircraft is also marked for the US Bicentennial of 1976, with a 'stars and stripes' motif on the engine intake.

Below left: In the RA-5C era, RVAH-3's aircraft generally carried a 'GJ' tailcode and '3xx' modex number. This aircraft, seen at NAS Key West in 1978, is decked out in a red lightning bolt marking seen on the RAG's aircraft towards the end of the Vigilante's service.

Below: Also seen in 1978, BuNo. 156625 was photographed at an open house at NAS Atlanta. Note the unusual black radome.

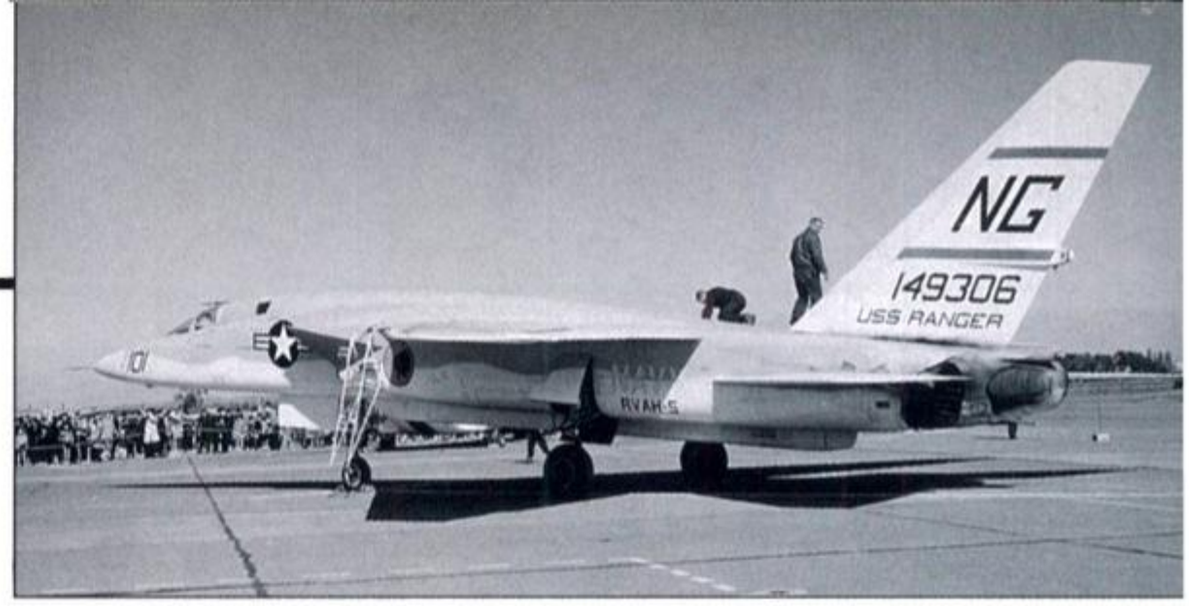
RVAH-5 'Savage Sons'

Established as VC-5 on 9 September 1948, this squadron participated in some of the earliest demonstrations of heavy attack aviation. On 7 March 1949, squadron skipper Captain John T. Hayward demonstrated the viability of carrier-based atomic delivery by launching in a P2V-3C Neptune from USS *Coral Sea* (CVA-43) in the Atlantic Ocean and completing a cross-country mock attack on the US West Coast. The squadron was the first to operate the AJ-1 Savage aboard ship and the first to make a transatlantic flight in a carrier aircraft. Redesignated VAH-5 in 1955, the squadron transitioned to the A3D Skywarrior in 1957. That year it took top honours in the initial Heavy Attack Wing One Bombing Derby, and in 1958 the squadron was named the top heavy attack squadron in the Navy. VAH-5 completed numerous deployments in USS *Forrestal* (CVA-59) before transitioning to the RA-5C Vigilante from 1963. The following year, the squadron became the first to carrier qualify in the RA-5C and was appropriately redesignated RVAH-5. Between 5 August 1964 and 6 May 1965, RVAH-5 was the first squadron to deploy operationally in the RA-5C and the first to take the Vigilante into combat in the skies over Vietnam. Between 1968 and 1973, RVAH-5 completed four additional deployments to Southeast Asia. RVAH-5 moved from NAS Sanford, Florida, to NAS Albany, Georgia, in 1968, and on 16 January 1974 the squadron shifted its base of operations to NAS Key West, Florida. RVAH-5 was disestablished on 30 September 1977.

VAH-5's first insignia emanated from its nickname, the 'Savage Sons', which arose from the squadron's operation of the AJ Savage aircraft. The squadron chose a caricature of an African tribesman as their insignia, and the squadron became known throughout the heavy attack community as the 'Mushmouths'. In April 1962 VAH-5 was operating onboard USS *Forrestal* (CVA-59) as part of a Presidential cruise in honour of ambassadors from various African nations; fearing the insignia might be offensive to the distinguished guests, the White House Chief of Protocol ordered it removed from all the squadron aircraft. To this end, the squadron adopted the 'one-eyed Indian' as its insignia in September 1962, which remained symbolic of their nickname.

CARRIER DEPLOYMENTS (shore code 'GK')

RVAH-5	CVW-9	USS *Ranger* (CVA-61)	5 Aug 1964-6 May 1965	RA-5C 'NG'/10x	Vietnam
RVAH-5	CVW-6	USS *America* (CVA-66)	30 Nov 1965-10 Jul 1966	RA-5C 'AE'/40x	Med
RVAH-5	CVW-6	USS *America* (CVA-66)	10 Jan 1967-20 Sep 1967	RA-5C 'AE'/40x	Med
RVAH-5	CVW-14	USS *Constellation* (CVA-64)	29 May 1968-31 Jan 1969	RA-5C 'NK'/1xx	Vietnam
RVAH-5	CVW-2	USS *Ranger* (CVA-61)	14 Oct 1969-1 Jun 1970	RA-5C 'NE'/60x	Vietnam
RVAH-5	CVW-14	USS *Enterprise* (CVAN-65)	11 Jun 1971-12 Feb 1972	RA-5C 'NK'/60x	Vietnam
RVAH-5	CVW-2	USS *Ranger* (CVA-61)	16 Nov 1972-22 Jun 1973	RA-5C 'NE'/60x	Vietnam
RVAH-5	CVW-9	USS *Constellation* (CVA-64)	21 Jun 1974-23 Dec 1974	RA-5C 'NG'/60x	WestPac
RVAH-5	CVW-2	USS *Ranger* (CV-61)	30 Jan 1976-7 Sep 1976	RA-5C 'NE'/61x	WestPac



Above: Converted from an A-5B to RA-5C standard, BuNo. 149306 was one of the first Vigilantes delivered to RVAH-5.

***Above: This aircraft carries the 'NK' code and '1xx' modex applied during 1968/69 for the squadron's second Vietnam deployment, aboard* Constellation.**

Above: RVAH-5 completed two spells in* Ranger *off Vietnam in the early 1970s. The red arrow on the tailfin was derived from that in the unit's badge.

Above: While ashore, RVAH-5 adopted 'GK' tailcodes and a tail badge with a native American theme. This aircraft is seen at Dobbins AFB in 1977, after the unit's final carrier deployment.

***Left: The 'Savage Sons' penultimate cruise was to the WestPac in 1974, the squadron joining CVW-9 aboard* Constellation.**

High over the Mediterranean a pair of Vigilantes breaks for the camera. RECATKRON 5 made two Mediterranean deployments, in 1965/66 and 1967.

RVAH-6 'Fleurs'

RVAH-6 traced its origins to VC-6, which was established on 6 January 1950. That same year, the squadron set a record of sorts when Lieutenant Commander Robert C. Starkey launched from USS *Coral Sea* (CVA-43) in a P2V-3C Neptune with a gross weight of 74,668 lb (33870 kg). At the time, it was the heaviest aircraft ever launched from a carrier. VC-6 was redesignated VAH-6 on 1 July 1956. Flying the AJ Savage and A3D Skywarrior, the squadron logged deployments to the Mediterranean and Far East, becoming the first squadron in the Pacific Fleet to deploy as a single unit in the A3D. While flying this aircraft from NAS Whidbey Island, Washington, the squadron captured six consecutive West Coast VAH Bomber Streams. In 1965, VAH-6 shifted its base of operations from Whidbey Island to NAS Sanford, Florida, and began transitioning to the RA-5C Vigilante. The 'Fleurs' received their first aircraft on 16 September 1965, and seven days later the squadron was redesignated RVAH-6. The squadron's first five cruises in its new aircraft involved combat operations in Vietnam. The maiden deployment proved highly successful, with RVAH-6 providing reconnaissance support for strikes against Ninh Binh and Thanh Hoa in North Vietnam, for which the 'Fleurs' were awarded the Navy Unit Commendation.

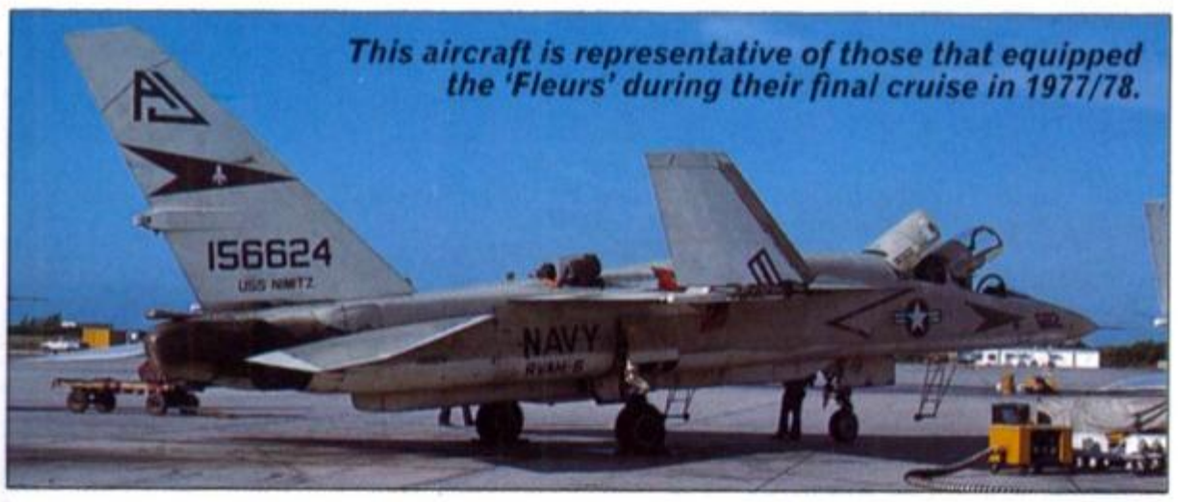
Another eventful cruise occurred in USS *Enterprise* (CVAN-65) in 1969. In January a 'Zuni' rocket warhead – overheated by exhaust from an aircraft starting unit – ignited a fire onboard the ship that resulted in the loss of 27 men, injury to 344 others, and the destruction of 15 aircraft. RVAH-6 was temporarily based ashore at NAS Barbers Point, Hawaii, while the ship was repaired. Deploying in March, *Enterprise* and its air wing joined three other carriers and their escorts in forming Task Force 71 for operations in the Sea of Japan after a Navy EC-121 Constellation was shot down by North Korean aircraft during a routine reconnaissance patrol over that body of water. Following this cruise, RVAH-6 received temporary assignment supporting RVAH-3, providing operational Vigilante aircraft to meet the increased training demands.

Post-Vietnam cruises included a Mediterranean deployment in USS *Forrestal* (CVA-59) in 1974, during which the squadron operated in support of American interests affected by the civil war in Cyprus. RVAH-6, which had shifted its home base to NAS Albany, Georgia, on 1 December 1967, transferred to NAS Key West, Florida, during 1974. The squadron was disestablished on 20 October 1978.

The insignia of the 'Fleurs' is replete with symbolism. The blue background represents the aerial mission of the squadron, while Omega is the last letter of the Greek alphabet and is generally interpreted to mean 'ultimate'. The golden trident denotes the sea and is symbolic of the squadron's carrier capability, while the white fleur-de-lis is common in French history and in heraldry denotes the sixth unit. A scroll featuring the squadron motto, 'Celeritas cum Accurate' (Speed with Accuracy), sometimes accompanied the insignia.

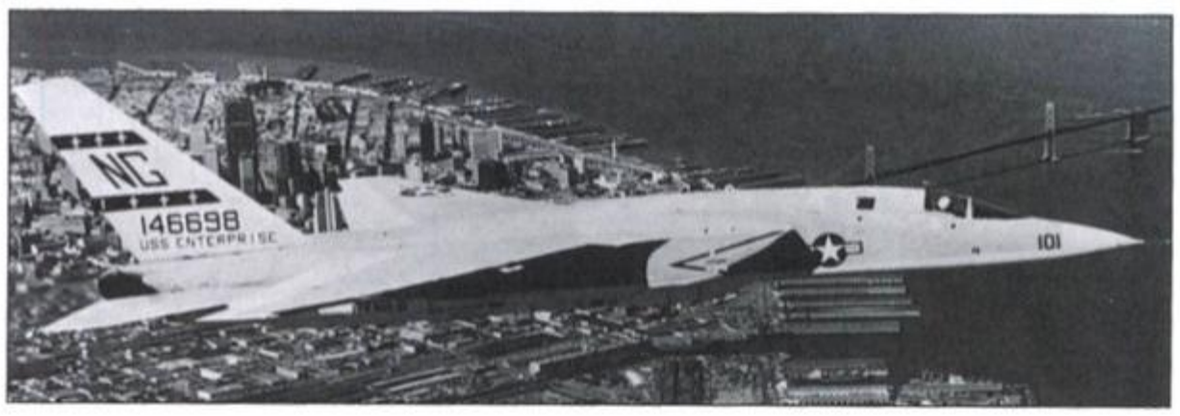
CARRIER DEPLOYMENTS (shore code 'GS')

RVAH-6	CVW-15	USS *Constellation* (CVA-64)	12 May 1966-3 Dec 1966	RA-5C 'NL'/70x	Vietnam
RVAH-6	CVW-2	USS *Ranger* (CVA-61)	4 Nov 1967-25 May 1968	RA-5C 'NE'/70x	Vietnam
RVAH-6	CVW-9	USS *Enterprise* (CVAN-65)	6 Jan 1969-2 Jul 1969	RA-5C 'NG'/60x	Vietnam
RVAH-6	CVW-11	USS *Kitty Hawk* (CVA-63)	6 Nov 1970-17 Jul 1971	RA-5C 'NH'/60x	Vietnam
RVAH-6	CVW-8	USS *America* (CVA-66)	5 Jun 1972-24 Mar 1973	RA-5C 'AJ'/60x	Vietnam
RVAH-6	CVW-17	USS *Forrestal* (CV-59)	11 Mar 1974-11 Sep 1974	RA-5C 'AA'/60x	Med
RVAH-6	CVW-11	USS *Kitty Hawk* (CV-63)	21 May 1975-15 Dec 1975	RA-5C 'NH'/60x	WestPac
RVAH-6	CVW-8	USS *Nimitz* (CVN-68)	1 Dec 1977-20 Jul 1978	RA-5C 'AJ'/60x	Med



This aircraft is representative of those that equipped the 'Fleurs' during their final cruise in 1977/78.

Above: 'GS' tailcodes have been applied to this somewhat weather-beaten aircraft, pictured in August 1973 after a spell in the South China Sea.



Above: This early production aircraft was among RVAH-6's first RA-5Cs. It started life as an A-5A and had been employed in ECM trials by the NATC.

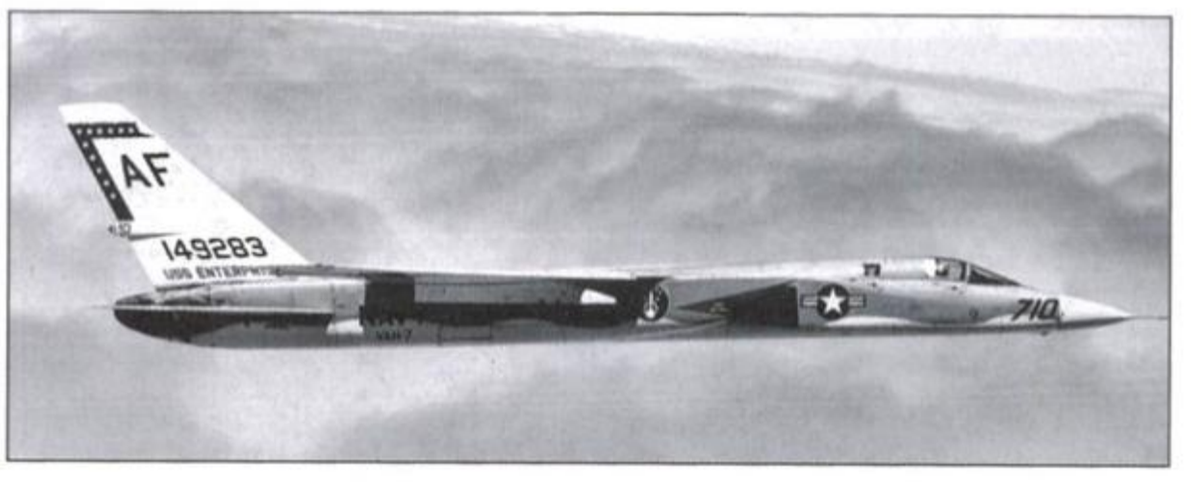
Above: Seen prior to its 1972/73 deployment aboard* America*, this near new RA-5C (complete with flasher pod) shares a ramp with a camouflaged F-102.

Above: The black nose chevron became a common 'Fleurs' marking in the early 1970s. BuNo. 156643 was the last production Vigilante.

Below: Seen being refuelled at NAS Cecil Field, BuNo. 156632 sports a Bicentennial tail stripe and* fleur-de-lis *tail markings.

VAH-7/RVAH-7 'Peacemakers of the Fleet'

RVAH-7 was originally established as VC-7 at NAS Moffett Field, California, on 30 October 1950. Less than a year later, the squadron shifted operations to the East Coast, deploying to the Mediterranean in AJ Savages. Redesignated VAH-7 in 1955, the squadron moved to NAS Sanford, Florida, and in March 1958 took delivery of its first A3D Skywarriors. VAH-7 was destined to fly this aircraft for only three years, for in 1961 the squadron began transitioning to the A-5A Vigilante. The first squadron to deploy with the new aircraft, VAH-7 operated extensively onboard USS *Enterprise* (CVAN-65), the world's first nuclear-powered aircraft-carrier, participating in the Cuban Missile Crisis blockade and the around-the-world cruise of Nuclear Task Force One. Transitioning to the RA-5C in



The tail striping on VAH-7's A-5As represented a '7' (reversed on the aircraft's starboard side); 'AF' codes were used by CVG-6 in 1962.

Vigilante Operators

August 1964, the squadron was redesignated RVAH-7 in December of that year. Over the course of the next eight years, the 'Peacemakers of the Fleet' logged four combat cruises to Southeast Asia. This included some 610 combat sorties during the 1972 cruise, which encompassed Operation Linebacker. During that period, RVAH-7 crews shot 504,320 rolls of film. RVAH-7 received the honour of making the last operational deployment in the Vigilante in USS *Ranger* (CV-61) in 1979, during which a squadron aircraft recorded the final carrier arrested landing by an RA-5C. An RVAH-7 crew also recorded the aircraft's last operational flight. The 'Peacemakers of the Fleet' operated from NAS Sanford, NAS Albany Georgia, and NAS Key West, Florida, and were disestablished at the latter station on 28 September 1979, the last RVAH squadron to pass into history.

Upon receiving the A-5A Vigilante, VAH-7 retired its insignia featuring a boxing glove in favour of one befitting its new aircraft. The new insignia featured a shield emblazoned with a supersonic airframe containing two frontier 'six-guns' cocked and ready. Like the sheriffs of the 19th century American West, the squadron maintained peace and order in the modern world. The halo of seven stars represented the domain of the Vigilante, flying high amid the stars.

CARRIER DEPLOYMENTS (shore code 'GL')

VAH-7	CVG-6	USS *Enterprise* (CVAN-65)	3 Aug 1962-11 Oct 1962	A3J-1 'AF'/7xx	Med
VAH-7	CVG-6	USS *Enterprise* (CVAN-65)	6 Feb 1963-4 Sep 1963	A-5A 'AE'/7xx	Med
VAH-7	CVG-6	USS *Enterprise* (CVAN-65)	8 Feb 1964-3 Oct 1964	A-5A 'AE'/7xx	Med
RVAH-7	CVW-9	USS *Enterprise* (CVAN-65)	26 Oct 1965-21 Jun 1966	RA-5C 'NG'/10x	Vietnam
RVAH-7	CVW-9	USS *Enterprise* (CVAN-65)	19 Nov 1966-6 Jul 1967	RA-5C 'NG'/10x	Vietnam
RVAH-7	CVW-7	USS *Independence* (CVA-62)	26 Apr 1968-27 Jan 1969	RA-5C 'AG'/60x	Med
RVAH-7	CVW-14	USS *Constellation* (CVA-64)	11 Aug 1969-8 May 1970	RA-5C 'NK'/60x	Vietnam
RVAH-7	CVW-17	USS *Forrestal* (CVA-59)	5 Jan 1971-2 Jul 1971	RA-5C 'AA'/60x	Med
RVAH-7	CVW-11	USS *Kitty Hawk* (CVA-63)	17 Feb 1972-28 Nov 1972	RA-5C 'NH'/60x	Vietnam
RVAH-7	CVW-11	USS *Kitty Hawk* (CVA-63)	23 Nov 1973-9 Jul 1974	RA-5C 'NH'/60x	WestPac
RVAH-7	CVW-17	USS *Forrestal* (CV-59)	5 Mar 1975-22 Sep 1975	RA-5C 'AA'/60x	Med
RVAH-7	CVW-11	USS *Kitty Hawk* (CV-63)	25 Oct 1977-15 May 1978	RA-5C 'NH'/61x	WestPac
RVAH-7	CVW-2	USS *Ranger* (CV-61)	21 Feb 1979-22 Sep 1979	RA-5C 'NE'/61x	WestPac

Above: In 1963 'AF' tailcodes were modified to read 'AE', as seen on this A-5A, victim of a nosegear collapse.

Above: Having been re-roled as a RECATKRON, the 'Peacemakers' made successive deployments to the Far East with CVW-9 in 1965/66 and 1966/67.

Below: For its 1968/69 Mediterranean cruise, RVAH-7 applied a powder blue tail stripe to its Vigilantes, seen here on BuNo. 156618.

Below: RECATKRON SEVEN reverted to the single star for the 1971 Mediterranean deployment, this time in white on a black tail.

Below: Though the tailcode became 'NH' with the change to CVW-17 for the Far Eastern cruise of 1972, the black tail and white star were retained.

Below: By the time of its 1978/79 WestPac cruise, the squadron's aircraft had reverted to a white tail.

Below: A black nose radome became a typical feature of RVAH-7 aircraft towards the end of the unit's life.

RVAH-9 'Hoot Owls'

Established in January 1953 as VC-9, flying a mixture of World War II TBM Avengers and a P2V-2 Neptune, the squadron soon transitioned to the AJ Savage in which it conducted some of the earliest aerial refuelling operations of carrier aircraft. After a land-based deployment to Port Lyautey, Morocco in 1954, the squadron was redesignated VAH-9 in November 1955 and made ready for its maiden at-sea deployment. Assigned to Carrier Air Group Three (CVG-3) in USS *Ticonderoga* (CVA-14), the squadron made one cruise with its AJ aircraft during December 1955-May 1956 before transitioning to A3D Skywarriors. Flying the 'Whale', VAH-9 deployed in USS *Saratoga* (CVA-60) in support of the Lebanon crisis in 1958, and subsequently logged four additional Mediterranean cruises onboard that carrier. The squadron began transitioning over to the RA-5C Vigilante during April 1964. Redesignated RVAH-9 on 3 June 1964, the squadron made most of its operational deployments to the Mediterranean, logging just two combat cruises to Vietnam. Based at NAS Sanford, Florida, when it transitioned to the Vigilante, the squadron shifted its base of operations to NAS Albany, Georgia, on 1 May 1968, and moved to NAS Key West, Florida, during January 1974. RVAH-9 was disestablished on 30 September 1977.

The squadron was unofficially known as the 'Hooters' during its days flying the AJ Savage. The insignia – an owl with a vicious scowl framed by two bolts of lightning – appeared in different versions, one of which included a bomb set against the backdrop of a cloud positioned at the intersection of the two lightning bolts.

CARRIER DEPLOYMENTS (shore code 'GM')

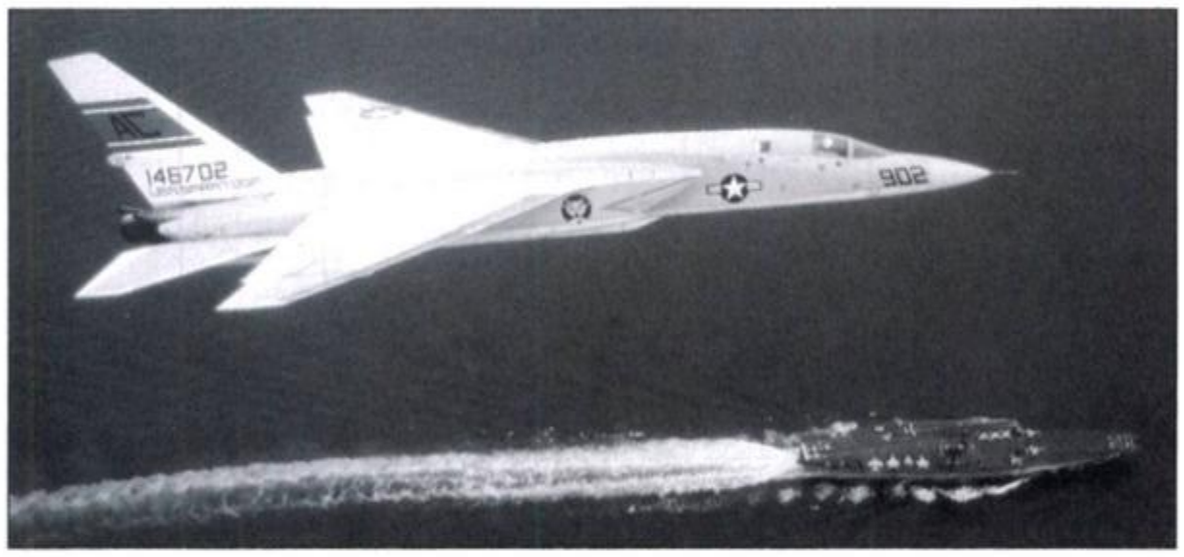
RVAH-9	CVW-3	USS *Saratoga* (CVA-60)	28 Nov 1964-12 Jul 1965	RA-5C 'AC'/9xx	Med
RVAH-9	CVW-14	USS *Ranger* (CVA-61)	10 Dec 1965-22 Aug 1966	RA-5C 'NK'/9xx	Vietnam
RVAH-9	CVW-3	USS *Saratoga* (CVA-60)	2 May 1967-6 Dec 1967	RA-5C 'AC'/90x	Med
RVAH-9	CVW-2	USS *Ranger* (CVA-61)	26 Oct 1968-17 May 1969	RA-5C 'NE'/70x	Vietnam
RVAH-9	CVW-3	USS *Saratoga* (CVA-60)	17 Jun 1970-11 Nov 1970	RA-5C 'AC'/60x	Med
RVAH-9	CVW-3	USS *Saratoga* (CVA-60)	7 Jun 1971-31 Oct 1971	RA-5C 'AC'/60x	Med
RVAH-9	CVW-17	USS *Forrestal* (CVA-59)	22 Sep 1972-6 Jul 1973	RA-5C 'AA'/60x	Med
RVAH-9	CVW-7	USS *Independence* (CV-62)	19 Jul 1974-21 Jan 1975	RA-5C 'AG'/60x	Med
RVAH-9	CVW-8	USS *Nimitz* (CVN-68)	7 Jul 1976-7 Feb 1977	RA-5C 'AJ'/60x	Med

Above: When ashore the 'Hoot Owls' aircraft carried 'GM' codes applied to represent the owl in their unit emblem.

Above: BuNo. 156624 was photographed aboard USS* Nimitz *on 9 September 1976, during the unit's final stint at sea.

Below: The 'Hoot Owls' last cruise was aboard* Nimitz *in 1976/77, CVW-8 using 'AJ' codes as seen on this aircraft at NAS Cecil Field in 1975.

With the USS* Saratoga *below, RA-5C BuNo. 146702 (among the first batch of A-5As) is seen during the squadron's first carrier deployment.



RVAH-11 'Checkertails'

Another former composite squadron, RVAH-11 was established as VC-8 on 3 December 1951. Like its sister squadrons at that time, VC-8 operated P2V-2/3 Neptune and AJ Savage aircraft. Moving to NAS Sanford, Florida in November 1955, the squadron received its first A3D Skywarriors two years later. Between 1959 and 1966, the 'Checkertails' logged six deployments to the Atlantic and Mediterranean in USS *Franklin D. Roosevelt* (CVA-42) and USS *Forrestal* (CVA-59). In 1966, the squadron began transitioning to the RA-5C Vigilante, and in July of that year it was redesignated RVAH-11. Deploying within the familiar confines of *Forrestal* in 1967, the squadron's maiden combat deployment ended in tragedy when fire erupted on the flight deck of the carrier off the coast of Vietnam, killing 132 crewmen and destroying numerous aircraft, including three 'Checkertail' Vigilantes. Returning to Sanford, the squadron made ready for another Western Pacific cruise in *Kitty Hawk* (CVA-63), which would prove far more successful than the first, earning the 'Checkertails' the distinction of being the first reconnaissance attack squadron to receive the coveted Presidential Unit Citation. During its 1971-1972 combat cruise, RVAH-11 also became the first squadron to capture tactical photographs of Haiphong harbour following the 1968 bombing halt. Having moved to NAS Albany, Georgia, in 1968, and then to NAS Key West, Florida, in 1974, RVAH-11 was disestablished on 1 June 1975.

RVAH-11 employed two insignias during its existence. The first depicted a chequered field emanating from the tail of an aircraft and covering the top half of the earth, and from this insignia the squadron derived its 'Checkertails' nickname. However, shortly after transitioning to RA-5Cs, the squadron adopted a new insignia. Superimposed on a yellow field, an atom represented the atomic and electronic capabilities of the squadron. Above the atom, an eagle formed three points of a five-point star and served as a symbol of American strength. The eagle, atom and star were all superimposed on an orange background that represented an explosion, a symbol of combat. Despite this new insignia, the squadron retained its original nickname.

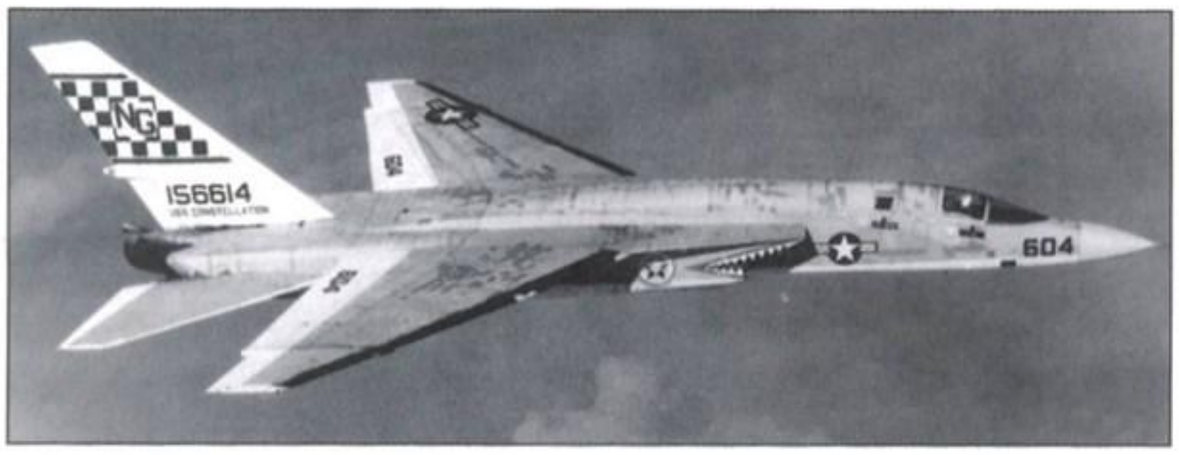
CARRIER DEPLOYMENTS (shore code 'GN')

RVAH-11	CVW-17	USS *Forrestal* (CVA-59)	6 Jun 1967-14 Sep 1967	RA-5C 'AA'/60x	Vietnam
RVAH-11	CVW-11	USS *Kitty Hawk* (CVA-63)	18 Nov 1967-28 Jun 1968	RA-5C 'NH'/60x	Vietnam
RVAH-11	CVW-11	USS *Kitty Hawk* (CVA-63)	30 Dec 1968-4 Sep 1969	RA-5C 'NH'/60x	Vietnam
RVAH-11	CVW-7	USS *Independence* (CVA-62)	23 Jun 1970-1 Feb 1971	RA-5C 'AG'/60x	Med
RVAH-11	CVW-9	USS *Constellation* (CVA-64)	1 Oct 1971-1 Jul 1972	RA-5C 'NG'/60x	Vietnam
RVAH-11	CVW-1	USS *John F. Kennedy* (CVA-67)	16 Apr 1973-1 Dec 1973	RA-5C 'AB'/60x	Med
RVAH-11	CVW-3	USS *Saratoga* (CV-60)	27 Sep 1974-19 Mar 1975	RA-5C 'AC'/60x	Med

***'Checkertails' personnel assemble in front of one their aircraft at Key West. Despite the tail marking to that effect, RVAH-11 did not service aboard* Nimitz.**

Above: RVAH-11 aircraft joined CVW-11 ('NH' tailcode) in **Kitty Hawk** *for two cruises in the Far East in 1967/68 and 1968/69.*

Above: RVAH-11 retained the same basic 'checkertail' design from about 1970, simply changing codes according to the Air Wing to which the unit was attached. 'AB' was the code of CVW-1 in 1973.



Seen during RVAH-11's 1971/72 Vietnam cruise, this weathered aircraft carries the short-lived intake sharkmouth marking that appeared at about this time. RVAH-11 aircraft also briefly carried the motto 'North American Racing Team – Phantom for Lunch Bunch'.

The black radome on this aircraft, seen in 1974, suggests that this CVW-3 aircraft was possibly an ex-'Peacemakers' aircraft.

RVAH-12 'Speartips'

While most RVAH squadrons were redesignated as VAH squadrons, RVAH-12 was the first squadron established as a reconnaissance attack squadron flying the RA-5C Vigilante. The 'Speartips' began life at NAS Sanford, Florida, on 1 July 1965, and during the squadron's operational career it made nine cruises, including four to the waters off Vietnam and five to the Mediterranean. During one of the latter cruises to the Mediterranean in USS *Independence* (CVA-62) during 1971-1972, squadron aircraft evaluated equipment as part of Project Snare. Employing an infra-red spectrum sensor fitted to the aircraft on top of the fuselage forward of the vertical tail, two RVAH-12 Vigilantes flew missions gathering laser emissions and other data from long-range Soviet bombers that shadowed the carrier battle group. RVAH-12 flew from NAS Albany, Georgia, and NAS Key West, Florida, and was disestablished on 2 July 1979.

The RVAH-12 insignia depicted a speartip moving through a field of blue at supersonic speed, with fields of red, white and blue emanating from it symbolic of a Mach wave. Appropriately, the squadron motto was 'We Point the Way'.

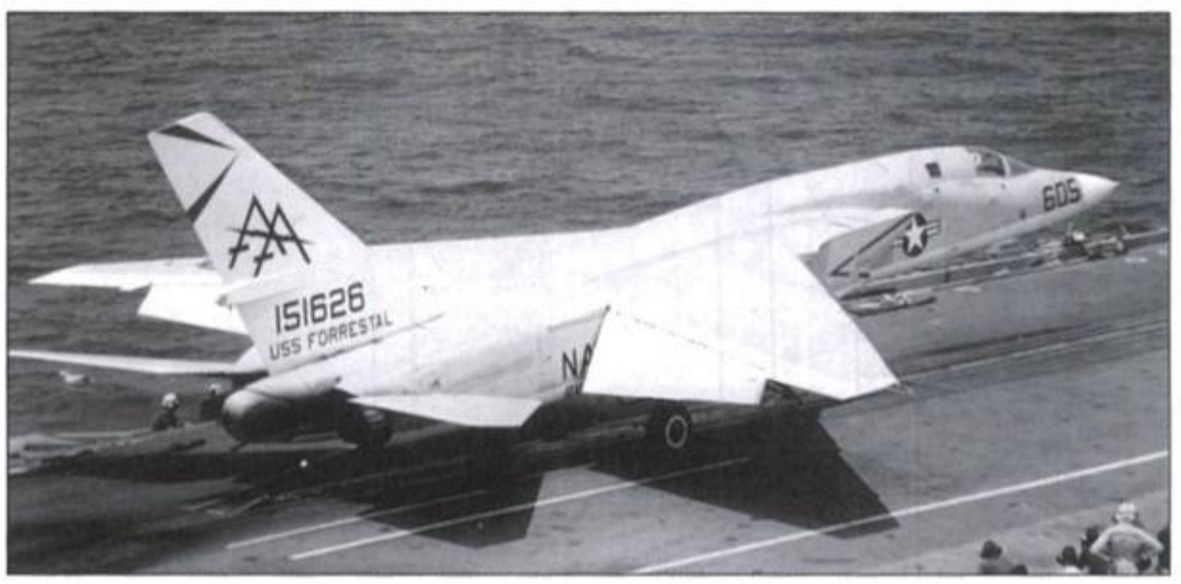
CARRIER DEPLOYMENTS (shore code 'GP')

RVAH-12 CVW-3	USS *Saratoga* (CVA-60)	11 Mar 1966-26 Oct 1966	RA-5C 'AC'/60x	Med
RVAH-12 CVW-14	USS *Constellation* (CVA-64)	29 Apr 1967-4 Dec 1967	RA-5C 'NK'/12x	Vietnam
RVAH-12 CVW-17	USS *Forrestal* (CVA-59)	22 Jul 1968-29 Apr 1969	RA-5C 'AA'/60x	Med
RVAH-12 CVW-9	USS *America* (CVA-66)	10 Apr 1970-21 Dec 1970	RA-5C 'NG'/60x	Vietnam
RVAH-12 CVW-7	USS *Independence* (CVA-62)	16 Sep 1971-16 Mar 1972	RA-5C 'AG'/60x	Med
RVAH-12 CVW-9	USS *Constellation* (CVA-64)	5 Jan 1973-11 Oct 1973	RA-5C 'NG'/60x	Vietnam
RVAH-12 CVW-14	USS *Enterprise* (CVAN-65)	17 Sep 1974-20 May 1975	RA-5C 'NK'/60x	Vietnam
RVAH-12 CVW-7	USS *Independence* (CV-62)	30 Mar 1977-21 Oct 1977	RA-5C 'AG'/60x	Med
RVAH-12 CVW-3	USS *Saratoga* (CV-60)	3 Oct 1978-4 Apr 1979	RA-5C 'AC'/60x	Med

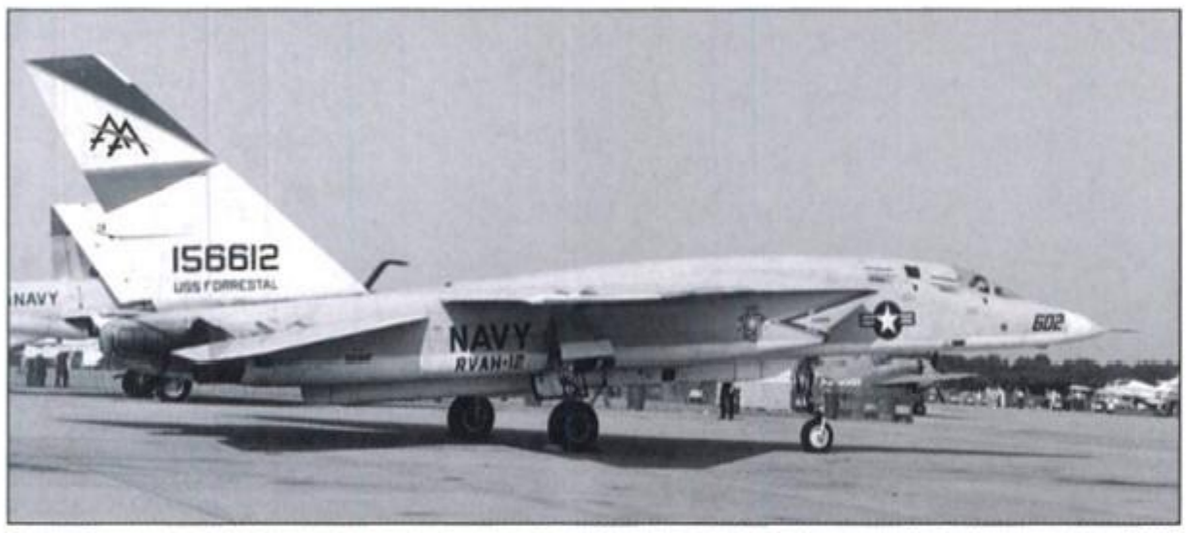
***Above: RVAH-12's first stint at sea was spent in the Mediterranean aboard* Saratoga,** *during summer 1966. Here, '600/AC' prepares to launch.*

***Below: Operations off Vietnam came in 1967 and were followed by another sojourn in the 'Med'. BuNo. 151626 is on the deck of* Forrestal.**

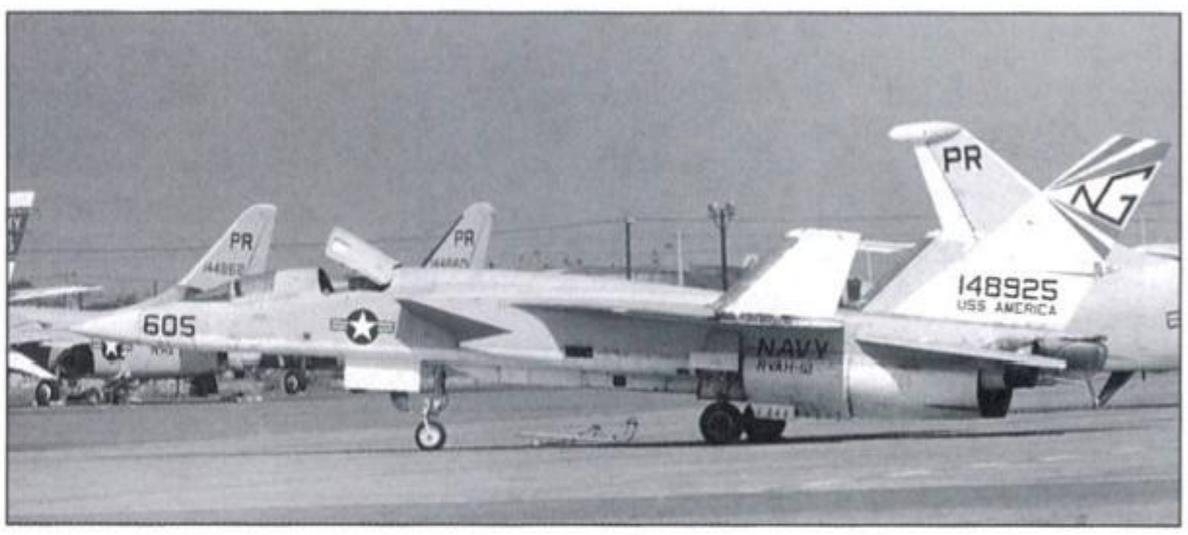
BuNo. 149300 was one of the A-5Bs converted to RA-5C standard. Here it is seen around the time of the 'Speartips' first Vietnam cruise.



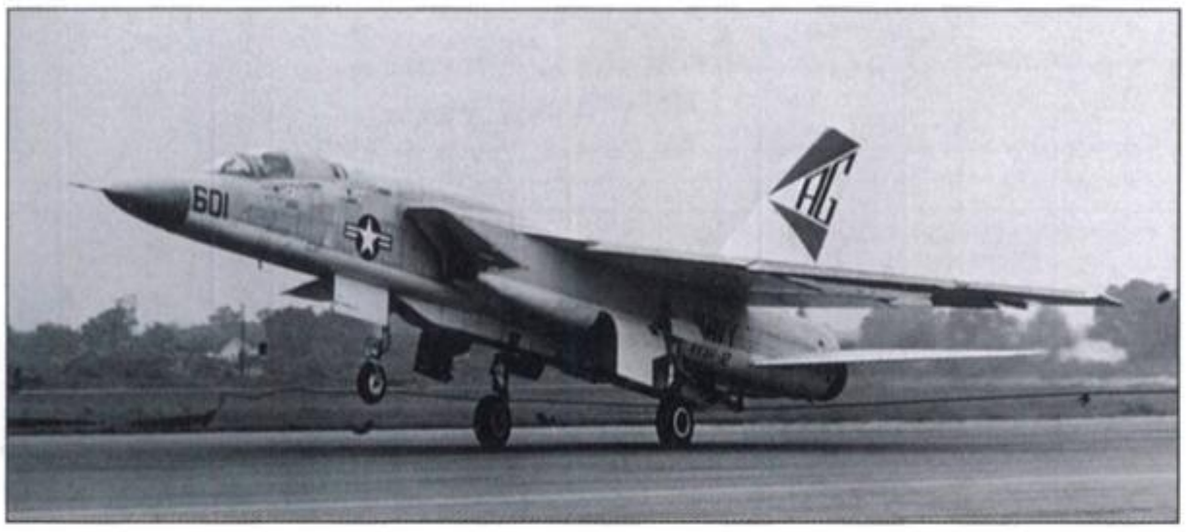
Immediately prior to disestablishment, the 'Speartips' inserted a Roman 'XII' symbol between the 'speartips' on the fins of their aircraft, the Air Wing code being displaced to a lower position.



Above: Curiously marked as a CVW-17 aircraft from 1968/69, late-production Vigilante BuNo. 156612 also sports Bicentennial markings.



Above: While with CVW-9 during 1970, RVAH-12's aircraft carried this tail marking variation, incorporating four 'speartips'.



One of the 'Speartips' aircraft demonstrates an arrested landing at a shore base. 'AG' codes indicate CVW-7.

During 1974, BuNo. 156640 sported this colourful radome, red intake markings and the 'NK' codes of CVW-14.

RVAH-13 'Bats'

Established as VAH-13 at NAS Sanford, Florida, on 3 January 1961, the 'Bats' first flew A3D/A-3 Skywarriors, logging two deployments in USS *Kitty Hawk* (CVA-63), including the ship's maiden cruise. During this time, the squadron operated from NAS Whidbey Island, Washington, winning numerous Bomber Streams at the base, conducting special operations for the Pacific Fleet and NORAD (North American Air Defense Command), and even flying a demonstration at the World's Fair in Seattle. In August 1964, the squadron returned to Sanford to transition into the RA-5C Vigilante, receiving the first of its new aircraft in October 1964. The following month the squadron was redesignated RVAH-13. The 'Bats' wasted little time in proving their mettle, becoming the first reconnaissance attack squadron to win a Bomber Stream on its first attempt. The squadron returned to *Kitty Hawk* in 1965, completing its first combat deployment to Vietnam and logging 545 combat sorties from its deck. All told, the squadron made four combat cruises. After moving to NAS Albany, Georgia, in December 1968, the squadron relocated to NAS Key West, Florida, in 1974. RVAH-13 passed into history upon its disestablishment on 30 June 1976.

RVAH-13 retained the bat insignia of VAH-13, which featured one of the nocturnal creatures descending for a kill against a background of orange.

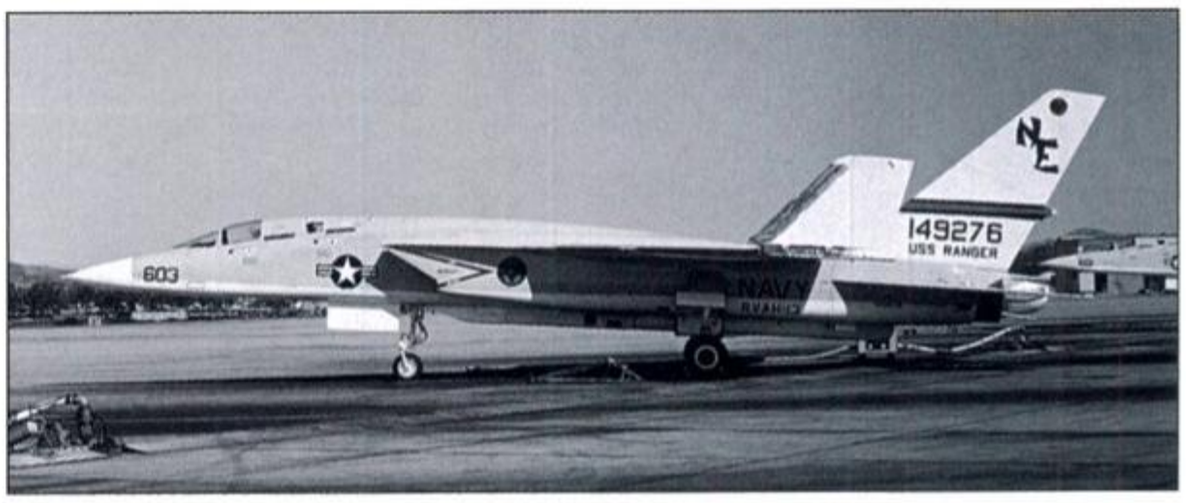
Unusually marked with the* Kitty Hawk*'s Air Wing number (CVW-11), this aircraft was photographed around the time of its first carrier deployment.

Vigilante Operators

CARRIER DEPLOYMENTS (shore code 'GR')				
RVAH-13 CVW-11	USS *Kitty Hawk* (CVA-63)	19 Oct 1965-13 Jun 1966	RA-5C 'NH'/60x	Vietnam
RVAH-13 CVW-11	USS *Kitty Hawk* (CVA-63)	5 Nov 1966-20 Jun 1967	RA-5C 'NH'/60x	Vietnam
RVAH-13 CVW-6	USS *America* (CVA-66)	10 Apr 1968-16 Dec 1968	RA-5C 'AE'/60x	Vietnam
RVAH-13 CVW-17	USS *Forrestal* (CVA-59)	2 Dec 1969-8 Jul 1970	RA-5C 'AA'/60x	Med
RVAH-13 CVW-8	USS *America* (CVA-66)	6 Jul 1971-16 Dec 1971	RA-5C 'AJ'/60x	Med
RVAH-13 CVW-14	USS *Enterprise* (CVAN-65)	12 Sep 1972-12 Jun 1973	RA-5C 'NK'/60x	Vietnam
RVAH-13 CVW-2	USS *Ranger* (CV-61)	7 May 1974-18 Oct 1974	RA-5C 'NE'/60x	WestPac
RVAH-13 CVW-7	USS *Independence* (CV-62)	15 Oct 1975-5 May 1976	RA-5C 'AG'/60x	Med

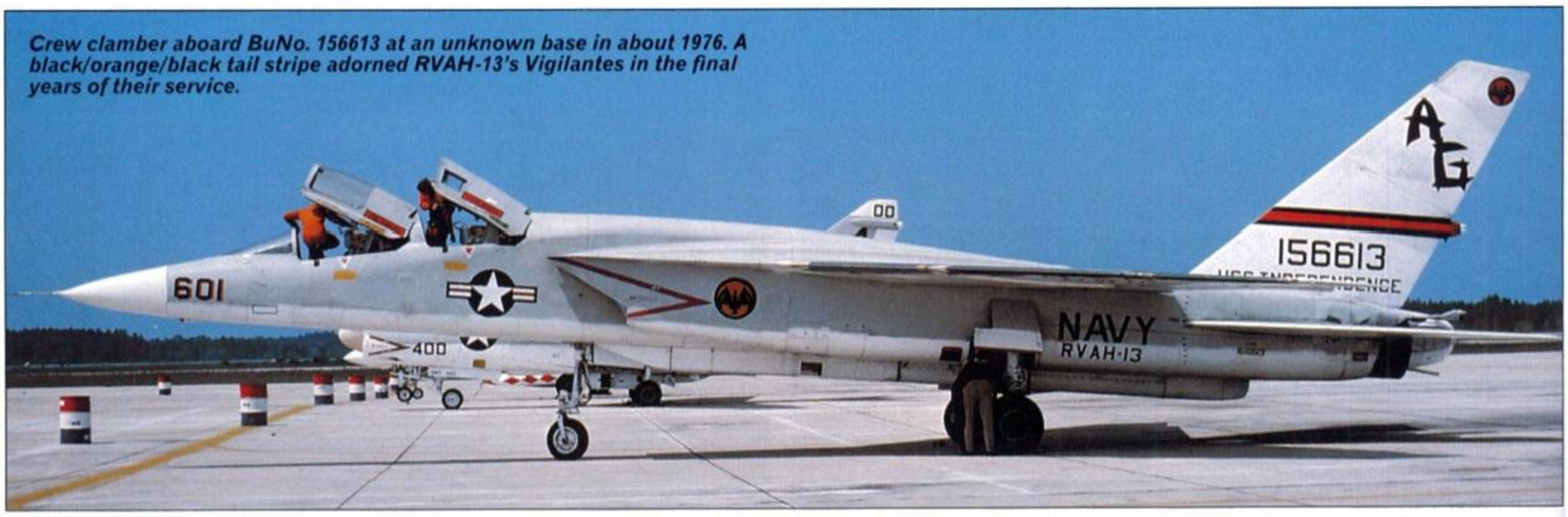
Right: Some time during mid-1968, the crowded deck of USS* America *played host to the aircraft of CVW-6, including A-6s, A-7s, F-4s and Vigilantes of RVAH-13. Note the six stars on the tail of most aircraft, indicating CVW-6.

Above: One of the later batch of RA-5Cs, this machine was eventually stricken at NAS Cubi Point, Philippines in 1979.



Above: Seen in 1974, BuNo. 149276 (a former A-5A) displays a 'Bats' insignia on its fin – a feature of RVAH-13's aircraft from about 1970.

Crew clamber aboard BuNo. 156613 at an unknown base in about 1976. A black/orange/black tail stripe adorned RVAH-13's Vigilantes in the final years of their service.



RVAH-14 'Eagle Eyes'

One of only two RVAH squadrons established as such, RVAH-14 began life at NAS Sanford, Florida, on 1 February 1968. The establishment of RVAH-14 coincided with the commissioning of USS *John F. Kennedy* (CVA-67) in September 1968, and the squadron's first three deployments came aboard 'Big John' as part of a newly created air wing assembled specifically to operate from the carrier. This included the ship's shakedown cruise, and a 1970-1971 deployment to the Mediterranean Sea in response to the Jordanian Crisis. RVAH-14 received the Meritorious Unit Commendation for its performance in the Middle East during this particular cruise. RVAH-14's final at-sea deployment came in USS *Independence* (CVA-62), and the squadron was disestablished at NAS Albany, Georgia, on 1 May 1974, less than four months after its return from this cruise. With only six years of operational service, RVAH-14 was the shortest-lived of the RA-5C squadrons, and also the first to be disestablished.

The RVAH-14 insignia combined ideas submitted by Rex Trout of North American Aviation, RVAH-14 skipper Commander D. F. Kirkpatrick, and Roy Crane, creator of the 'Buzz Sawyer' comic strip. It consisted of a black eagle on a blue background with a multicoloured spectrum radiating from the eagle's eye. The eagle and its proverbial 'eagle eye' represented the RA-5C Vigilante, the claws depicted the aircraft's ever-present attack capability, and the coloured spectrum was symbolic of the multiple reconnaissance capabilities of the aircraft.

Upper right: Confined to the Mediterranean, RVAH-14 joined the* Kennedy *for its shakedown cruise in 1969, as part of CVW-1.

Right: A stylised eagle's head and blue tail 'feathers' formed the unit's distinctive markings. This aircraft was aboard* Independence *in 1973/74.

CARRIER DEPLOYMENTS (shore code 'GQ')				
RVAH-14 CVW-1	USS *John F. Kennedy* (CVA-67)	5 Apr 1969-21 Dec 1969	RA-5C 'AB'/60x	Med
RVAH-14 CVW-1	USS *John F. Kennedy* (CVA-67)	14 Sep 1970-28 Feb 1970	RA-5C 'AB'/60x	Med
RVAH-14 CVW-1	USS *John F. Kennedy* (CVA-67)	1 Dec 1971-6 Oct 1972	RA-5C 'AB'/60x	Med
RVAH-14 CVW-7	USS *Independence* (CVA-62)	21 Jun 1973-19 Jan 1974	RA-5C 'AG'/60x	Med

Test and evaluation units

Naval Air Test Center, Patuxent River

In its time-honoured role conducting development and suitability trials on new naval aircraft, the NATC received the first nine A3J-1s off the production line (BuNos 146694-146702), the first example arriving in mid-1959. BuNo. 146697 made the first carrier landings and take-offs from an aircraft-carrier from 22 July 1960. Examples of both the A-5B and RA-5C also passed through the NATC's hands during the course of the Vigilante programme, as illustrated by the accompanying photographs.

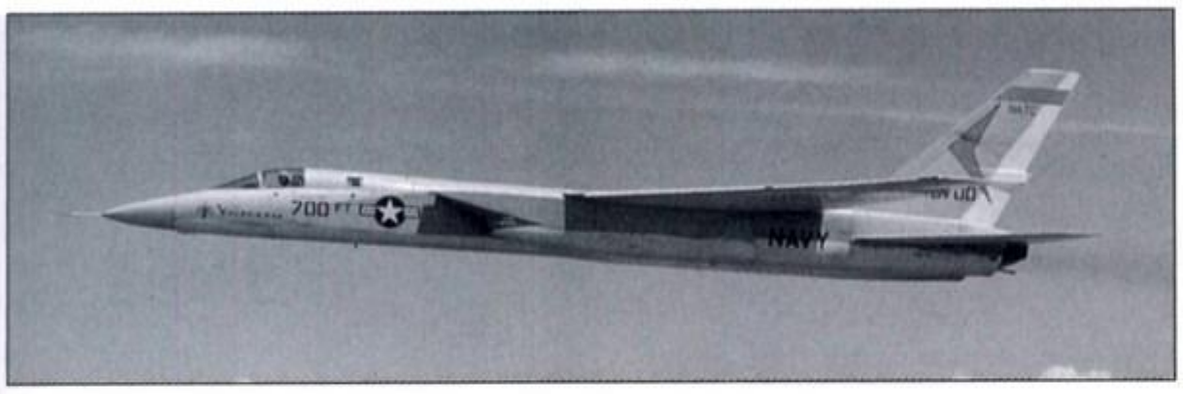
BuNo. 147850, as one of the first 16 A3J-1s, was assigned to the initial Vigilante flight test programme. One of four aircraft turned over the Navy, it made 133 test flights totalling 215 hours 20 minutes, including stores carriage trials. Here it is seen with a load of a dozen Mk 82 iron bombs.

Air Development Squadron Five (VX-5)

On 26 June 1962, the Vigilante's nuclear weapons test programme began, under the control of Det A, VX-5. This ran for six months, ending on 31 December. Test objectives included determining the separation characteristics of all nuclear stores in all release modes and the adequacy and reliability of the AN/ASB-12 bomb directing set. In all 136 flights were made, totalling 183.1 hours.

At least two A3J-1s from the second production batch (BuNos 146856 and 146857) were assigned to VX-5 for these tests, which were undertaken at the Naval Weapons Evaluation Center, Kirtland AFB

VX-5 concluded that the Vigilante was a superior bombing platform but that the linear bomb bay and rearward bomb ejection system were not sufficiently reliable. Conventional stores, on the other hand, presented few problems even when assymetric loads were released.



Seen here in NATC colours, A3J-1 BuNo. 146700 was destroyed in an accident during flight trials on 17 March 1961.

Below: The second production RA-5C was immediately assigned to the NATC for trials. Most systems and performance tests were conducted at the Naval Ordnance Test Station, China Lake, California.

Below: NATC-assigned A3J-1 BuNo. 146697 was engaged in carrier trials from July 1960. Here the aircraft lands aboard USS Saratoga.

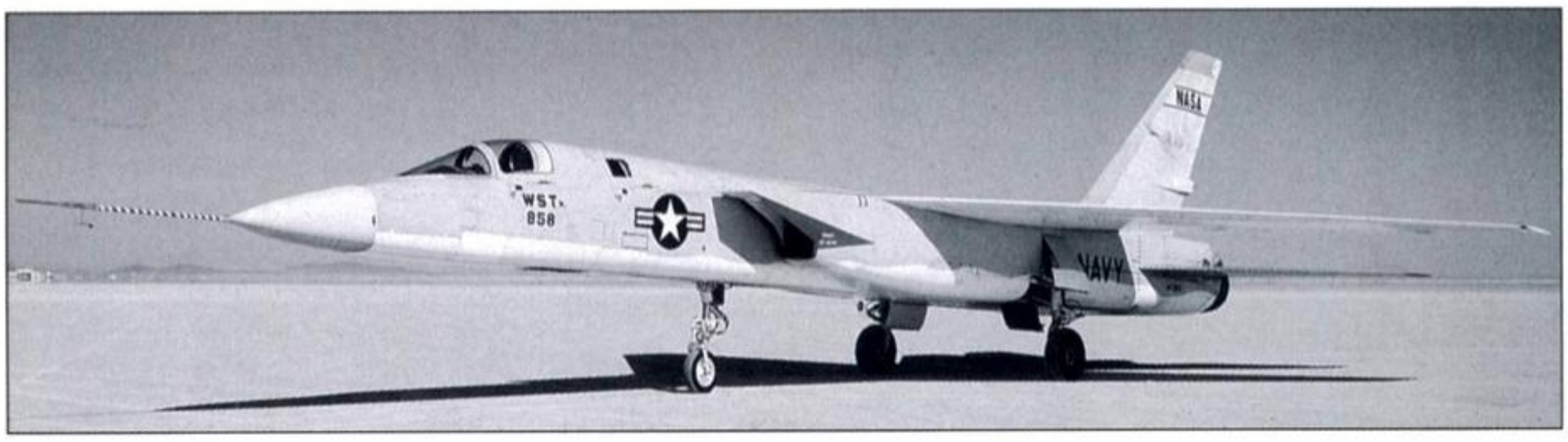
Below: A3J-1 BuNo. 147856 wears the 'XE' codes of test squadron VX-5 in this photograph taken at NAS Pensacola and dated 10 June 1961. Note the red scalloped paint work.

United States Air Force

At least one Vigilante (the prototype, BuNo. 145157) was loaned to the USAF in the 1960s for evaluation. A short flight test programme was undertaken in order to ascertain whether the aitrcraft would be of potential use to the Air Force.

NASA

Between March and May 1963 the 20th A-5A (BuNo. 147858, right) was assigned to the National Aeronautics & Space Administration's Dryden Flight Research Facility at Edwards AFB, California. Here it supported the simulation studies carried out as part of the American SST programme, as well as associated sonic boom and noise pollution research programmes. The brevity of its stay with NASA ensured that it was not allocated a NASA serial number. At the conclusion of this work the aircraft was returned to the Navy and converted to RA-5C standard at NAA's Columbus plant.



Last days of Hitler's Luftwaffe

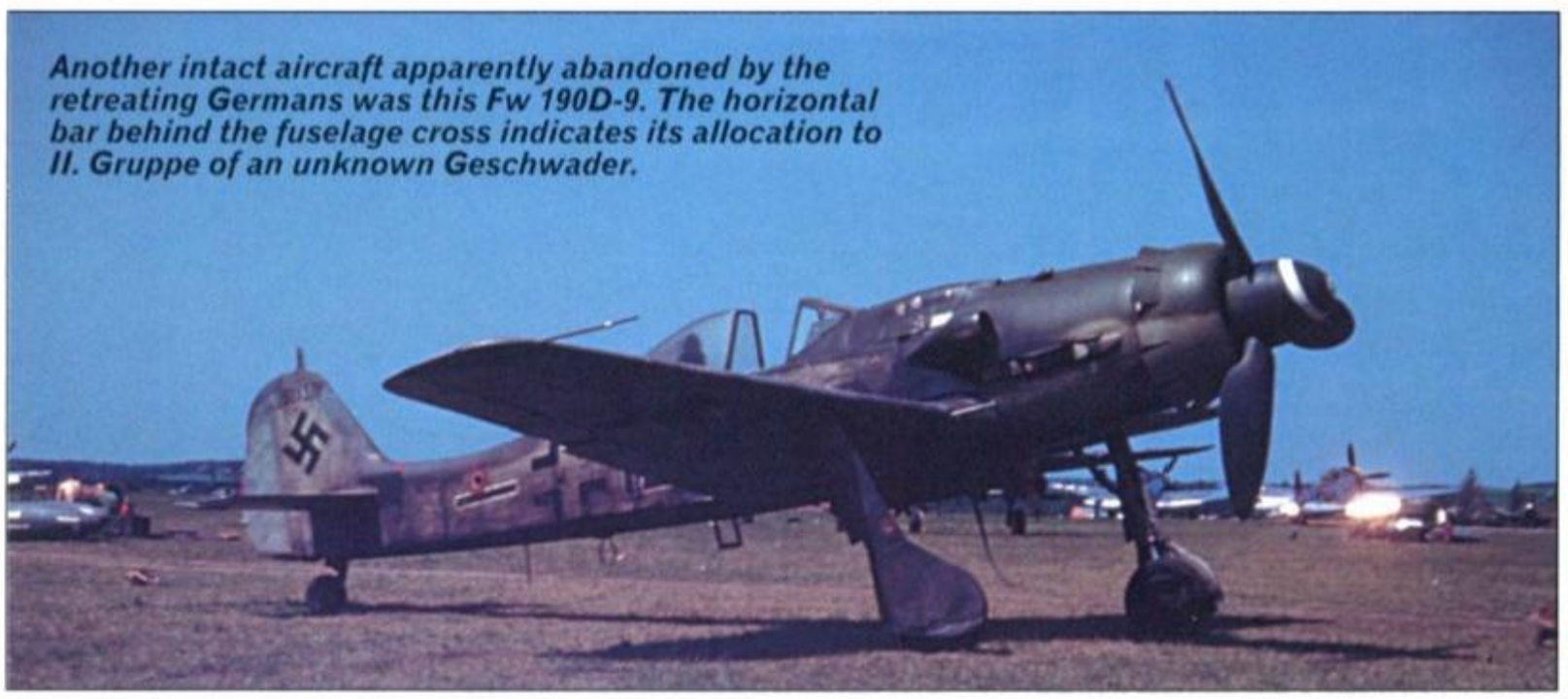
Fürth/Nuremberg airfield, May 1945

Ralph 'Jack' Woolner was a Staff Sergeant with the 10th Photographic Group (Reconnaissance), USAAF when he found himself at Fürth (R-30), outside Nuremberg in May 1945. Scattered around the airfield were numerous abandoned Luftwaffe aircraft – some virtually complete, others mere hulks – which Woolner not only photographed, but captured in colour.

Above: Seen outside one of Fürth's large hangars are a Bf 109G-10/R2 and an Fw 190A-9. The F-6D Mustangs in the background are 10th Photographic Group (R) machines, as indicated by the blue/white tail checks.

Above: Not all the aircraft at Fürth were powered. This training glider closely resembles the post-war RAF's Grasshopper TX.Mk 1.

Left: Minus its tail, a Bf 110G-4 night-fighter is inspected by a passing GI. The aircraft carries the 'C9' codes of NJG 5.



Another intact aircraft apparently abandoned by the retreating Germans was this Fw 190D-9. The horizontal bar behind the fuselage cross indicates its allocation to II. Gruppe of an unknown Geschwader.

Above: A wrecked Bf 109G-6 sits dumped in trees on the airfield.

Above: Bücker's Bü 181 Bestmann was an all-wood cabin monoplane primarily employed by the Luftwaffe largely for training and other auxiliary duties, such as glider-towing.

Left: The long-span wings on this Ju 87 'Stuka' identify it as a D-5. By the end of the war, Ju 87s on the Western Front were confined to Nachtschlachtgruppen.

Right: This remarkably intact 'Gustav', a camera-equipped Bf 109G-10/R2, wears the '5F' code of Aufklärungsgruppe 14, a reconnaissance unit that had flown twin-engined types on the Russian front earlier in the war. In the background is Skipper, *an F-6D with the 10th PG(R).*

Below: This overall view of Fürth gives an impression of the size of the airfield. As well as an Fw 190D (or Ta 152), at least two of the 10th PG(R)'s F-5 Lightnings are visible.

Above: The Siebel Si 204D-1 was built by SNCAC in Vichy France from 1942 and undertook light transport as well as instrument, radio, radar and navigation training duties for the Luftwaffe.

Above: Decoys were soon deployed upon arrival at a new airfield.

Left: The factory codes on this Fw 190G-3 suggest that it was wrecked soon after delivery.

Left: Souvenir hunters have removed the swastikas from the tailfin of this burnt-out Ju 52/3m. The 'HL' code indicates 1. Staffel/I. Gruppe, but the Geschwader code cannot be discerned.

Below: This scrap pile includes Fw 190s and Bf 109s in varying states of disassembly.

432nd TRW
Phantoms at war, 1972

Tony Marshall flew his first combat mission as a 'back-seater' with the 13th TFS, 432nd TRW in May 1971. Based at Udorn RTAFB, he compiled a unique photographic record during missions over North Vietnam and Laos. Flying 'fast-FAC' sorties from June 1972, he was shot down the following month in F-4E 69-3289 – a 58th TFS aircraft detached to the 432nd TRW – and imprisoned in Hanoi by the North Vietnamese until release during 1973.

Above: Tony Marshall (right foreground) takes care of the 13th TFS mascot, a black panther named 'Eldridge' (allegedly after the Black Panther Party activist Eldridge Cleaver), during a photocall for the squadron's aircrew sometime before August 1973, when the unit's 'OC' tailcode was replaced by the 'UD' of its parent, the 432nd TRW.

Right: Marshall's pilot gets a little closer than normal behind a fellow 13th TFS aircraft for this photograph, taken during a bombing mission on a target in North Vietnam.

Left: F-4D 66-8825 of the 555th TFS unloads a pair of GBU-10 Paveway I 2,000-lb laser-guided bombs on a North Vietnamese or Laotian target. '825 was among the 72 Block 32 and 33 aircraft equipped with ARN-92 LORAN (LOng RAnge Navigation) equipment and its associated dorsal 'towel rail' antenna. LORAN was developed during the latter stages of World War II and allowed precision navigation at night using signals from distant ground stations. Primarily intended for target marking and in the 'seeding' of the Ho Chi Minh Trail with 'Igloo White' sensors, these F-4Ds were employed principally by the 25th and 497th TFSs (8th TFW) and the 555th.

Probably better known for their exploits in the MiGCAP role, the 13th and 555th TFSs did their share of 'mud-moving'. With air-to-air armament comprising a single AIM-7, F-4D 66-0262 (below) is armed with a pair of SUU-13 submunitions dispensers, able to carry a variety of submunition types; those illustrated held 40 bomblets, often of the 'Dragontooth' anti-personnel mine type. (Note also the AN/ALQ-101(V)-1 jamming pod in the forward right-hand Sparrow well.) Use of SUU-13 by F-4 operators (demonstrated by a pair of 555th TFS aircraft, right) is believed to have been comparatively rare.

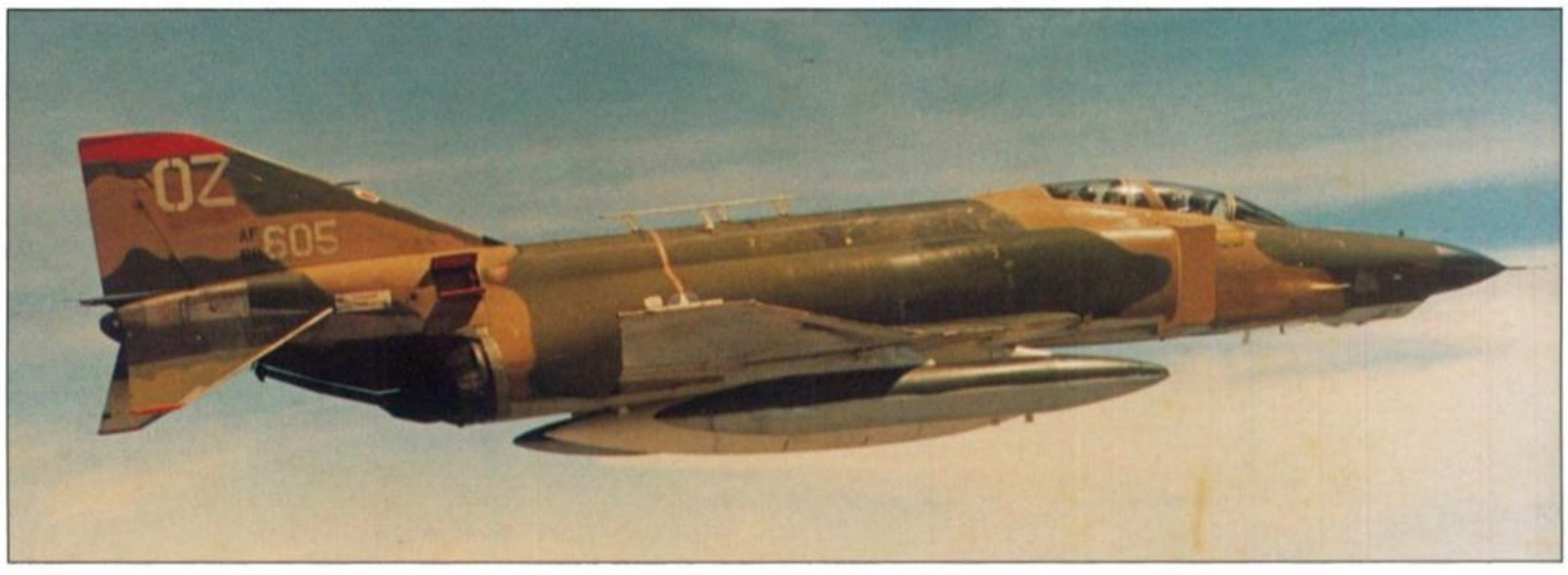
Above: Aircraft from three of the 432nd's constituent squadrons – the 555th TFS 'Triple Nickel' (tailcode 'OY'/green fincap), the 13th TFS 'Black Panthers' ('OC'/blue) and the 14th TRS ('OZ'/red) gather round a KC-135A to top-up their tanks en route to a target during Linebacker operations in 1972. The 14th TRS had been deployed in 1967 to take over high threat reconnaissance tasks from 20th TRS RF-101Cs. It was to be the only RF-4C combat unit to employ LORAN-equipped aircraft, as seen here.

432nd TRW Phantoms at war, 1972

Seen over a short section of the stretch of the Mekong River that forms the Thai/Laotian border, LORAN-equipped F-4D 66-8714 hauls a load of Mk 82s with 'daisy-cutter' fuse extenders to a target in Laos.

Right: Equipped for a MiGCAP, this 13th TFS F-4D carries a mixed load comprising three AIM-7s, an AN/ALQ-101 jammer on the starboard inner pylon and a pair of AIM-4D Falcons. AIM-4s were employed for only a brief period by F-4Ds in Vietnam and were consequently responsible for just five kills between October 1967 and February 1968 (two by 13th TFS crews). The IR-guided AAM gained a bad reputation due to its inability to lock-on quickly and the fact that it did not employ a proximity fuse – both features attributable to the fact that it was designed for use against strategic targets.

Right: Block 40 and 41 RF-4Cs equipped with LORAN joined the 14th TRS in 1969. Of all the 'recce' Phantoms in Southeast Asia, these were the aircraft best able to make full use of the aircraft's AN/APQ-102A sideways-looking radar to provide accurate targeting information in all weathers. 68-0605 has evidently been using photoflash cartridge ejector (above the engine tailpipe), which was turned over to chaff dispensing during daytime missions.



Above: 66-7673 of the 555th TFS unleashes its load of Mk 82s through cloud. Though outwardly little different from the F-4C, the D-model offered a considerable improvement in air-to-ground capability. While with the 8th TFW at Ubon RTAFB, the 555th TFS was the first combat unit to re-equip with F-4Ds, in 1967.

Left: Coolant from a 'two-can' AN/ALQ-101 jammer set occupying the forward AIM-7 bays of 65-0680 has stained the undersides of the aircraft (as well as the rear pair of Sparrows!). '680 was one of the dozen F-4Ds modified to carry the Pave Knife laser pod, used by the 433rd TFS, 8th TFW from 1971 to designate targets for Paveway I LGBs, including the infamous Paul Doumer Bridge.

Left: The 'back-seater' aboard 66-8737 was probably making good use of his aircraft's ARN-92 LORAN set to find the target, through solid cloud cover, for a pair of BLU-27 napalm canisters. Fire bombs were not often dropped from altitude, being more commonly associated with low-level CAS missions.

Right: Tony Marshall photographed this pair of 388th TFW F-4Es as it overflew a 'Lima' site in Laos during a mission for which his aircraft was acting as pathfinder. The 'JV'-coded 469th TFS/388th TFW was the first combat unit to employ the F-4E, becoming established at Korat RTAFB in November 1968, using aircraft flown in by the 40th TFS. 67-0290 (foreground) is an early Block 33 aircraft, with the original gun blast diffuser and proudly wears the 388th's trademark sharkmouth. Stores include Mk 82 bombs with 'daisy cutter' fuse extenders.

Above: In May 1969, the 34th TFS/388th TFW received F-4Es. With the arrival of the 'Echo', came a change in crewing practice, aircraft being manned by a pilot and dedicated WSO, rather than the two rated pilots. A new 'systems mentality' began to prevail and wings began to specialise. While the 8th TFW took on a precision strike role, the 432nd concentrated on counter-air, the 366th specialised in border MiGCAPs and the 388th CAS and tactical interdiction. 'Daisy cutter' Mk 82s and an AN/ALQ-71 ECM pod make up this 34th TFS aircraft's load.

As the sun rises on a new day, bombed-up 'Triple Nickel' and 'Black Panther' F-4Ds join 6010th WWS Thunderchiefs on a tanker over Thailand.

Above: A 'Triple Nickel' F-4D acts as pathfinder for a pair of VA-22 Corsairs from aboard USS Coral Sea, the Phantom dropping a mixture of extended-fuse Mk 82s and cluster bombs, while the A-7s unload 'slick' Mk 82s. The ARN-92 LORAN-equipped F-4Ds were generally tasked with one of three main roles. 'Fast-FAC' pathfinding over Laos, whereby targets would be marked with flares or white phosphorous rockets for Navy or USAF strike aircraft; sensor-sowing of ADSIDs (Air-Delivered Seismic Intrusion Devices) in support of 'Igloo White' or all-weather pathfinding at medium and high altitudes, as shown here.

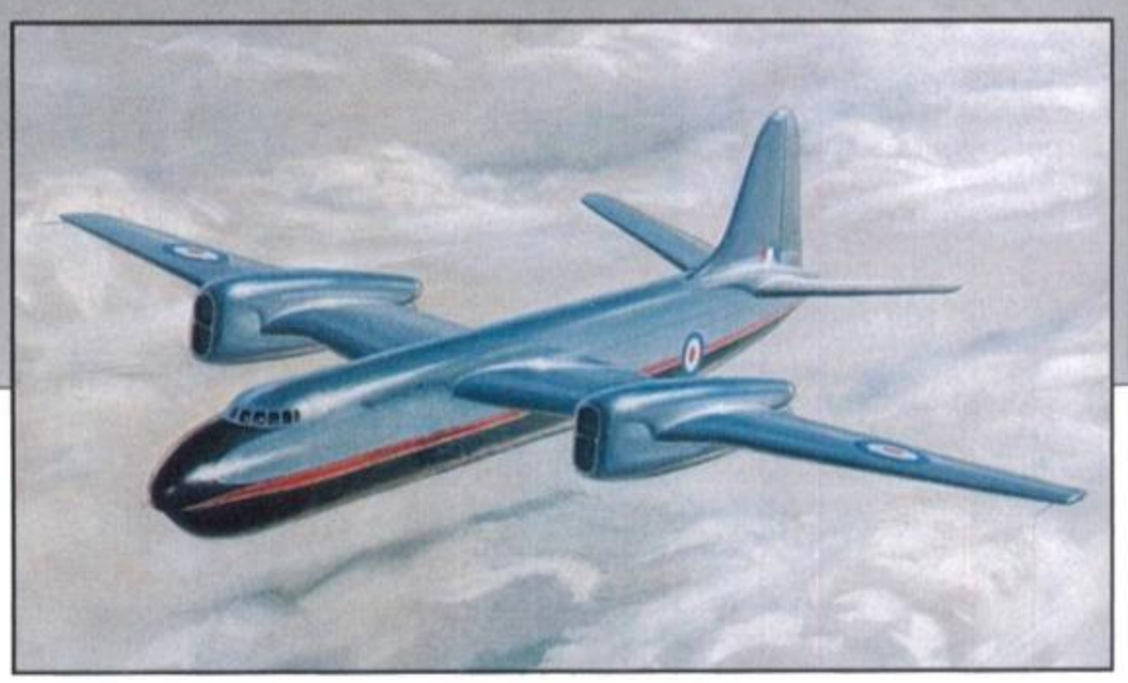
Above: The 'Spring Offensive' of late March 1972 by the North Vietnamese brought full-scale retaliatory strikes which necessitated massive reinforcement from the US; nine extra USAF F-4 squadrons arrived under Operation Constant Guard. Units attached to the 432nd TRW at Udorn included the F-4E-equipped 308th TFS/31st TFW from Homestead AFB, Florida, stationed at Udorn between April and July 1972. Note this aircraft (67-0254) retains a TAC badge on its fin.

Left: Another Constant Guard unit was the 523rd TFS/405th TFW from Clark Field in the Philippines, operating 'PN'-coded F-4Ds with the 432nd TFW for six months from April 1972. Also seen in this view is a Det 1, 561st TFS F-105G Wild Weasel aircraft.

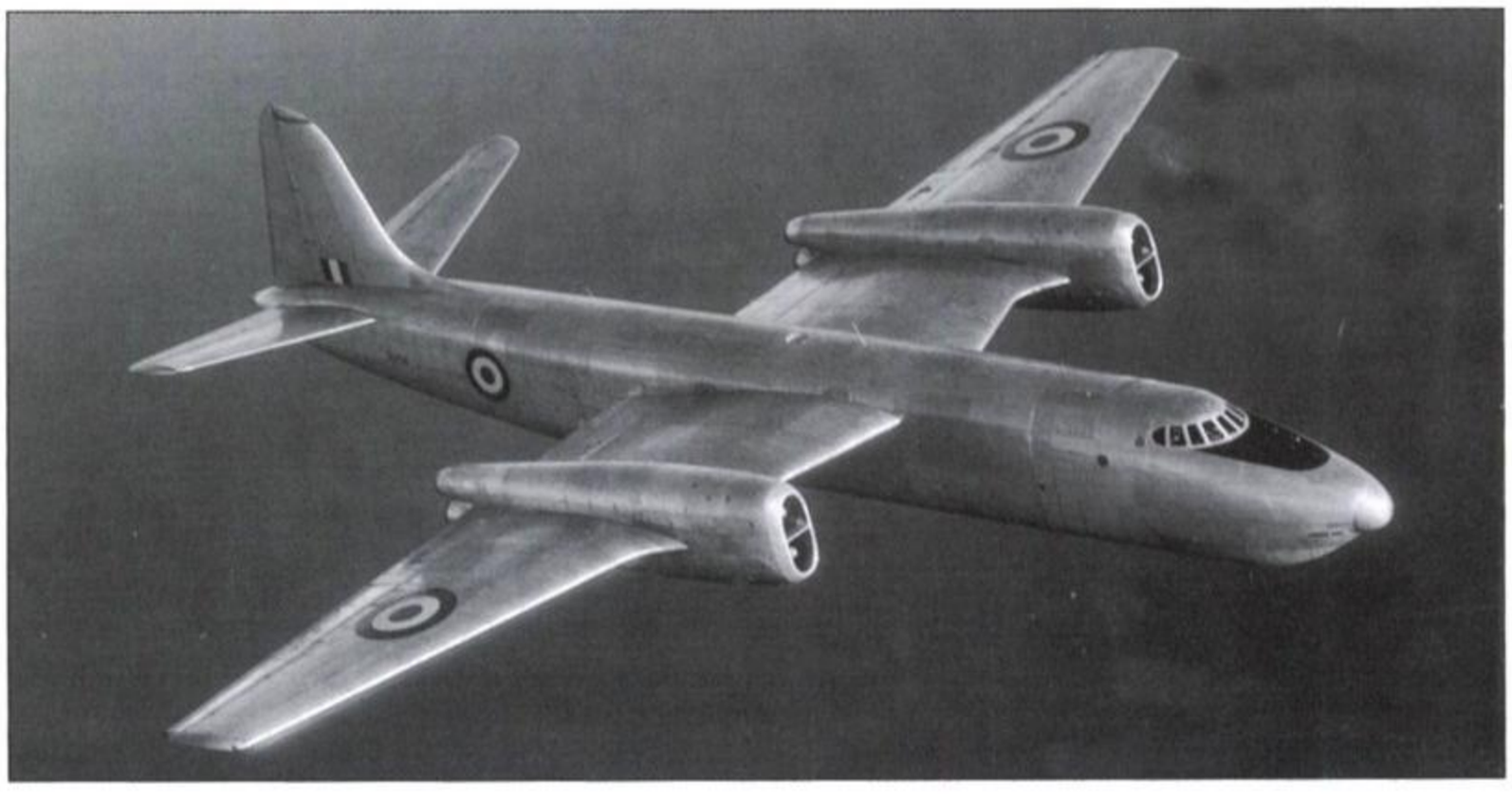
Short SA.4 Sperrin

The RAF's 'Insurance Bomber'

Designed as a hedge against the failure of more sophisticated medium bombers being developed by other British manufacturers, the Short SA.4 (subsequently christened the Sperrin) sought to blend new technologies with conservative aerodynamics.



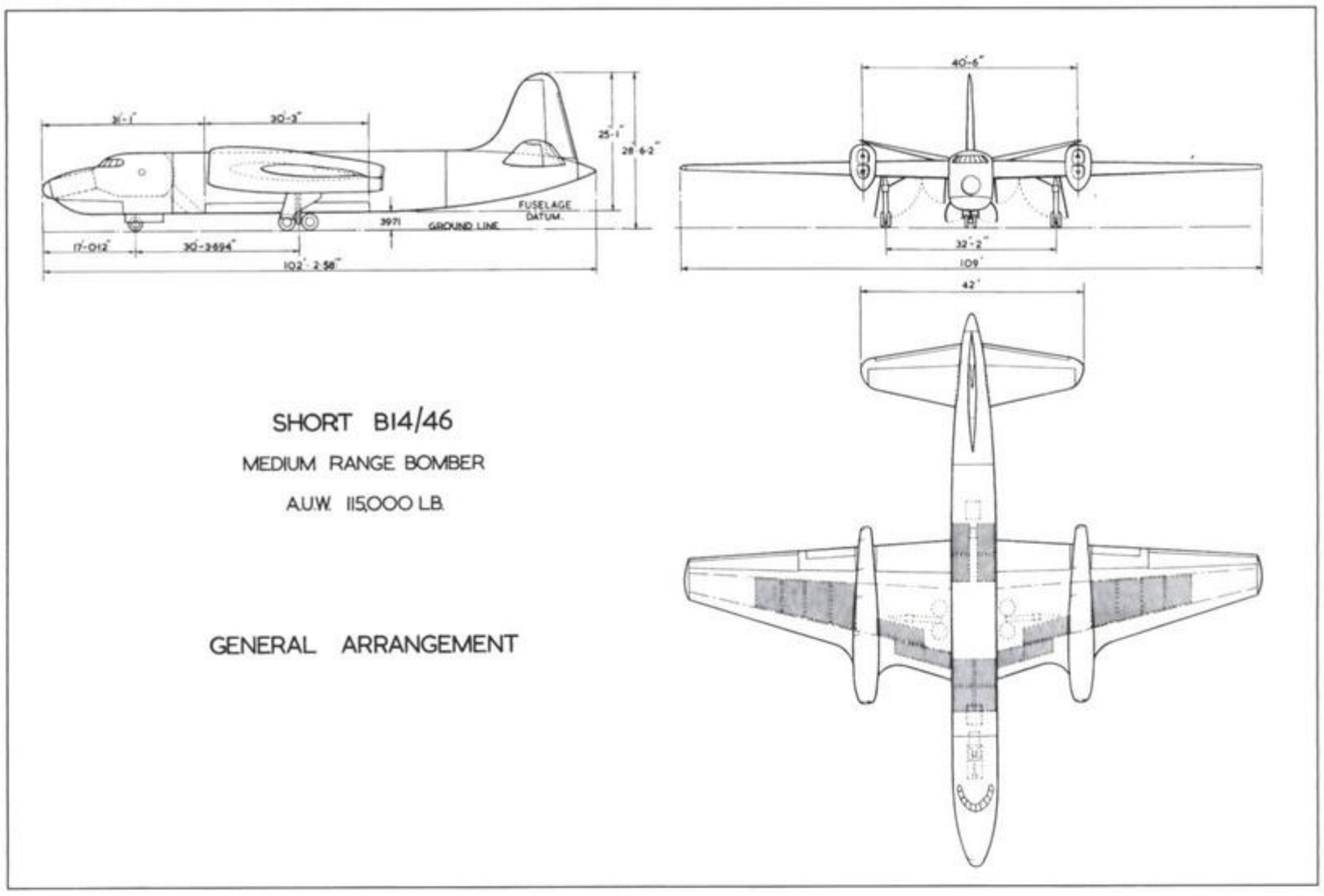
Any prospect of the SA.4 entering service with the RAF, however, was dashed some time before the first prototype made its maiden flight, thanks to the markedly superior performance promised by Vickers' rival interim jet bomber, the swept-wing Valiant, together with the speed with which Vickers was able to develop its design. Despite this, in their role as trials aircraft the two Sperrins manufactured at the Short Brothers and Harland factory at Queen's Island, Belfast, were destined to play a vital early role in the development of the RAF's jet medium bomber force.



Conception

The origins of the SA.4 can be seen to reflect three of the key themes that underlay the design and procurement of British military aircraft in the period immediately following World War II: the manner in which advances in aerodynamics and propulsion technology during that war had changed the face of air warfare; the uncertainty that such changes engendered among the operational requirements, design and production staffs of the Air Ministry, the Ministry of Supply and Britain's aircraft manufacturers; and the overwhelming need on the part of the UK to develop and deploy atomic weapons and delivery systems in the

Colour schemes for the two flying examples of the Short SA.4 for the most part consisted of a natural metal finish for both VX158 (Short construction number SH.1600, left) and VX161 (SH.1601, top). VX161 retained this scheme throughout, but VX158 gained a temporary special scheme for its public unveiling at the 1951 SBAC show at Farnborough (inset).



The general arrangement of Short's B.14/46 proposal was conventional in most respects, the obvious exception being the 'stacked' powerplant layout. The shaded areas in the plan view indicate the fuel tank layout.

shortest possible time.

By 1945, the RAF's strategic bomber force in the UK (RAF Bomber Command) consisted almost entirely of squadrons equipped with either the Avro Lancaster or the Handley Page Halifax; their replacement – the Avro Lincoln – was waiting in the wings. While both the Lancaster and Halifax could boast impressive war records, it was nevertheless clear to the Air Staff that the era of the piston-engined, unpressurised strategic bomber was rapidly drawing to a close. Combat experience emphasised the need for future aircraft to operate at much greater altitudes and speeds than those attained by the wartime generation of British heavy bombers; this, in turn, would require jet engines, pressurisation and the use of airborne radar to enable bombers to find and strike targets accurately from altitude – particularly at night or in poor weather. A further concern was the question of range; British bombers were designed primarily for use against targets in western Europe, and as a consequence lacked the payload/range performance required to strike more distant objectives.

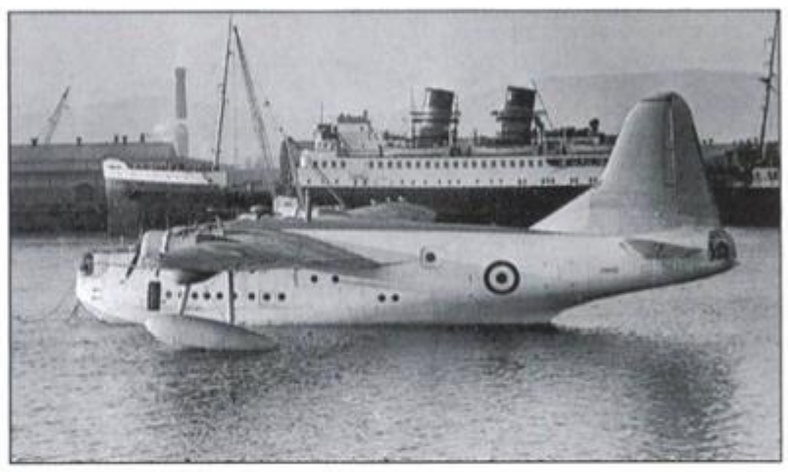
It was against this background that the Air Ministry and the Ministry of Supply began to consider the way forward for the British strategic bomber force. By early 1946, a draft Operational Requirement for a future British strategic bomber – OR230 – had been prepared by the Air Staff. This requirement called for an aircraft capable of worldwide operation and able to carry a 10,000-lb (4536-kg) (atomic) bomb over a distance of 2,000 miles (3218 km). In order to ensure that the bomber could penetrate enemy air defence networks, the aircraft was to have a cruising speed in the region of 500 kt (922 km/h) at altitudes of 35,000 to 50,000 ft (10668-15240 m), and to carry a comprehensive array of electronic warfare equipment for self-defence.

OR230 represented a remarkable attempt to achieve a quantum leap in bomber performance and capability. Indeed, such were the demands of the Operational Requirement that the Ministry of Supply initially refused to accept it, on the grounds that it was simply too difficult to meet. As it became clear that the development and introduction into service of a bomber to this requirement was likely to be hugely expensive and fraught with risk, the Directorate of Operational Requirements turned instead to a slightly less demanding specification for a jet medium bomber – Operational Requirement OR229 – which was initially circulated in draft form on 7 November 1946.

"A bomber to succeed the Lincoln"

The first issue of Air Staff Requirement No. OR229: Medium Range Bomber was released on 7 January 1947. This encapsulated the Air Staff's desire for a bomber capable of carrying a 10,000-lb atomic bomb over a maximum operational radius of action of 1,500 nm (2778 km) (requiring a still air range of 3,350 nm/6204 km at 50,000 ft), cruising at altitudes of 35,000 to 50,000 ft (10668-15240 m) at 500 kt (922 km/h); maximum speed in level flight was to be "as high as possible". Once again, the design had to provide for the installation of a comprehensive array of electronic warfare, bombing and navigation systems.

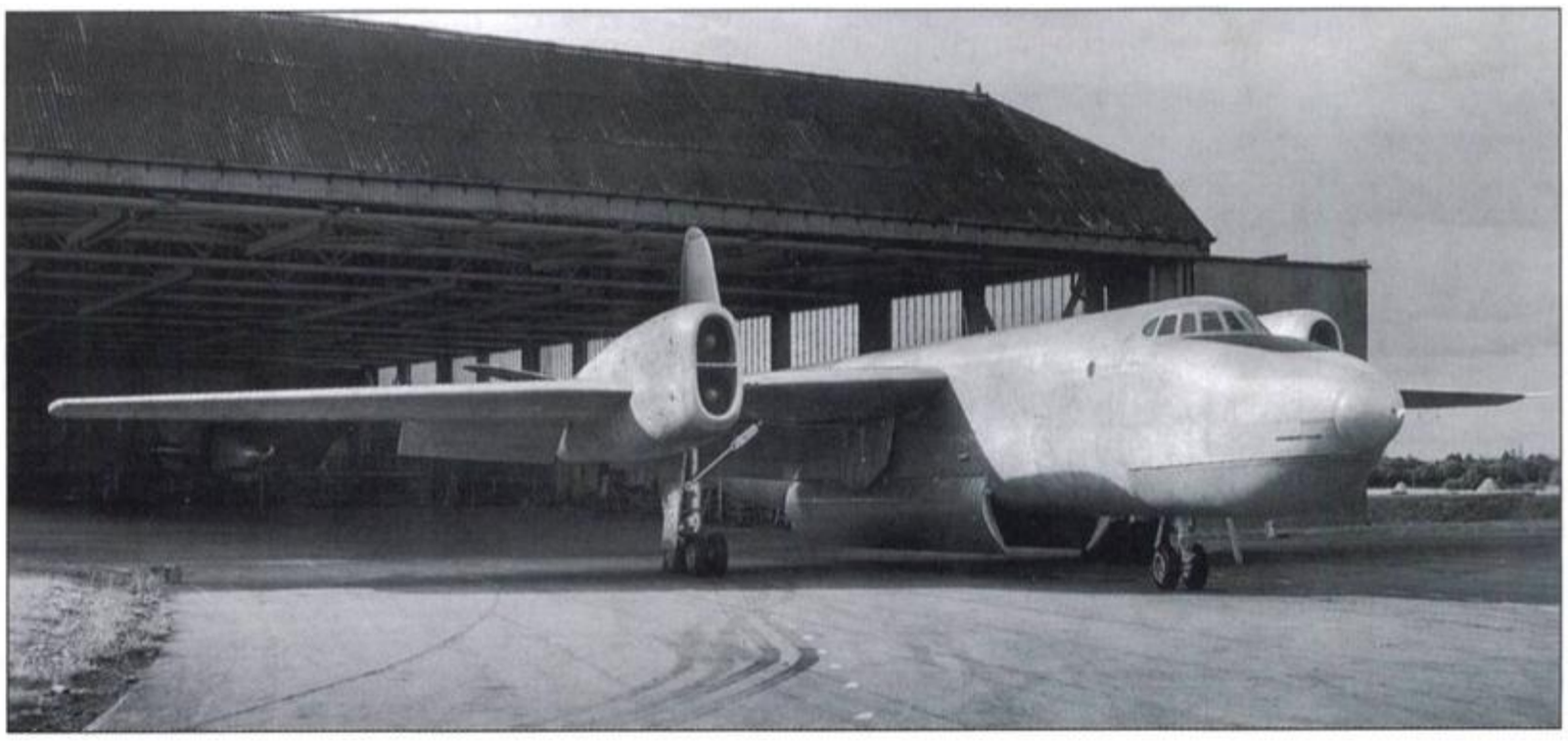
While offering less potential for failure than OR230, OR229 still required the use of advanced aerodynamics as yet untried in the UK. As a consequence, it was decided that provision should be made to ensure that any problems encountered while developing aircraft to the latter specification did not leave the RAF without a jet medium bomber. Attention focused in particular upon a series of designs already prepared by Shorts, combining the fuselage of its rejected proposal to the OR229 specification (B35/46) with straight wings. Following a meeting of the Air Ministry's Operational Requirements Committee on 17 December 1946, on 20 December the Principal Director of Technical Development (Air) at the Ministry of Supply, S. Scott-Hall, noted in a letter to the Technical Director of Short Bros,



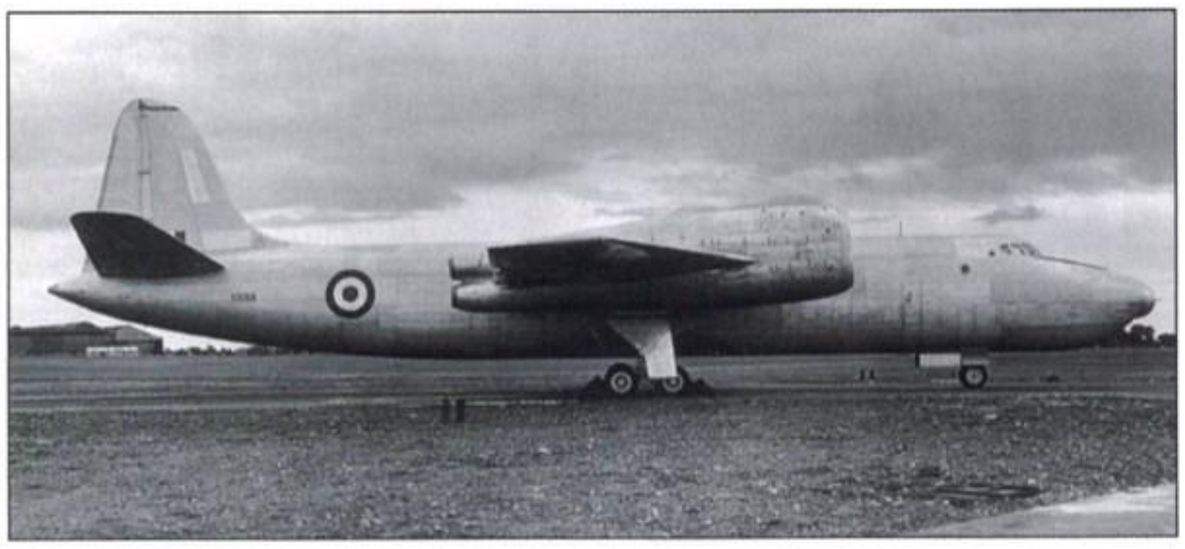
From June 1949 Sunderland Mk 5 PP151 was loaned to Shorts to flight-test the SA.4's flight control system, a Sperrin fin and rudder being fitted to the aircraft.

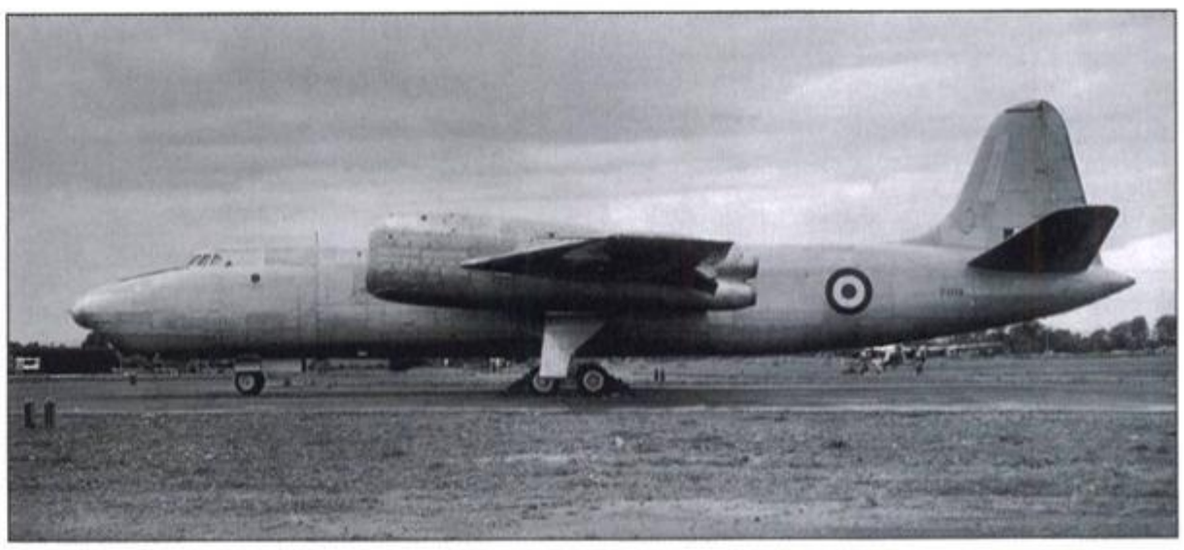
Sir John Buchanan, that, "it was realised that to meet the full long-range requirements, an aeroplane of 200,000 lb all-up weight would be required, and that this would be very costly and technically somewhat of a gamble. The Air Staff therefore prepared a medium-range requirement identical with the requirement for the long-range aircraft, except in respect of range.

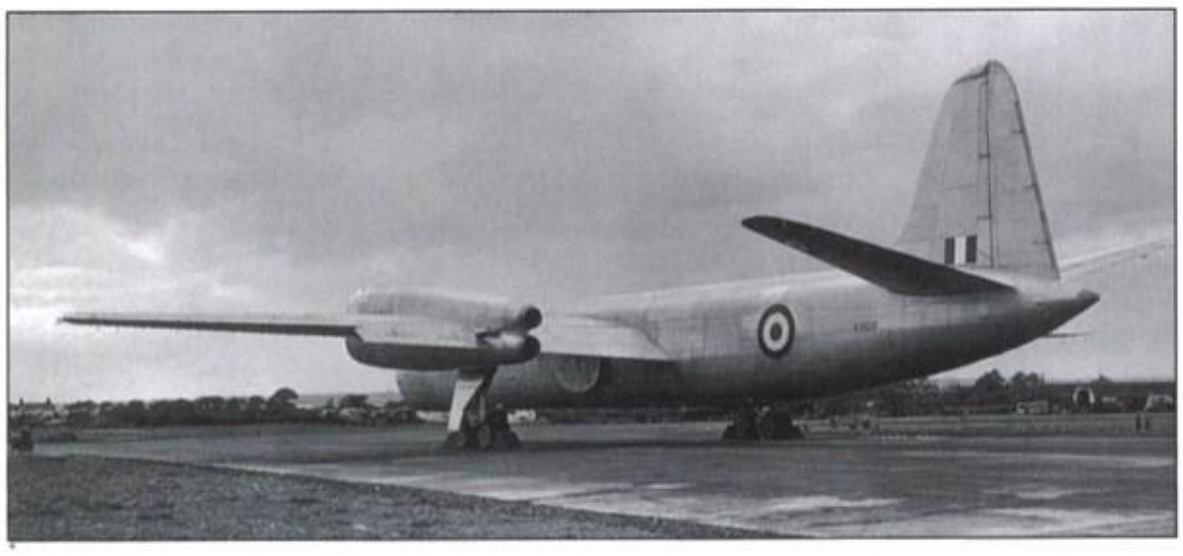
"This medium-range requirement still called for an aircraft of such speed performance that a swept-back wing would almost certainly be necessary. The uncertainties of such a design

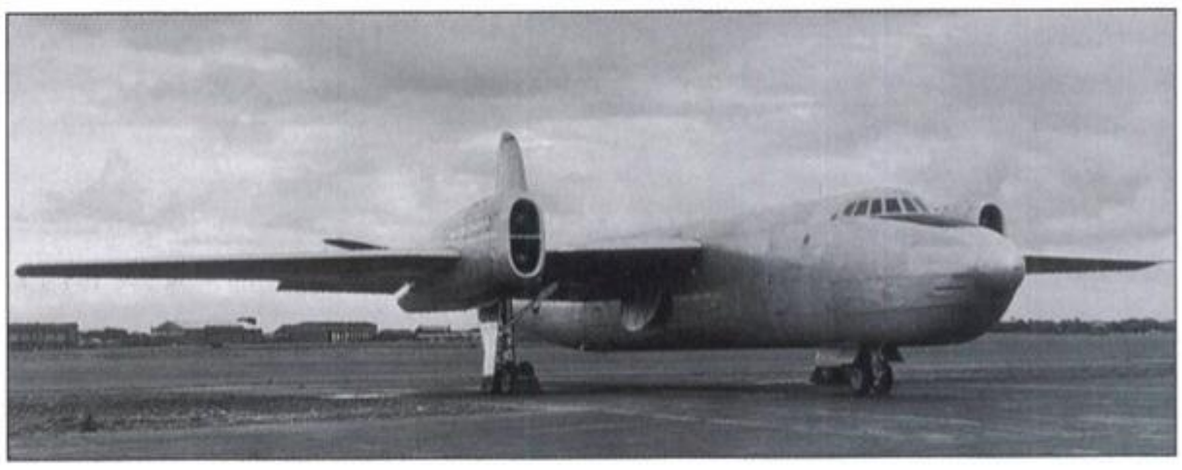


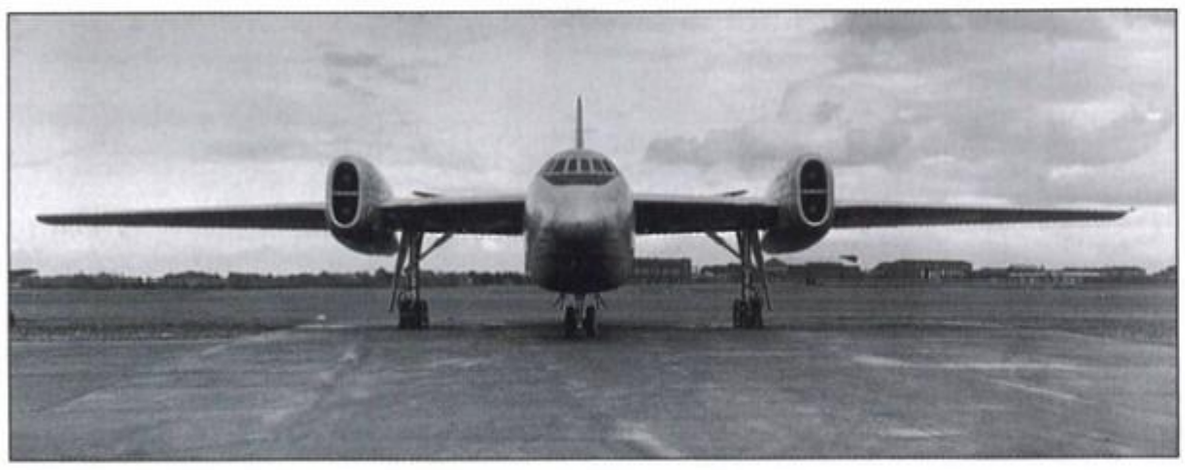
With its twin bomb bay doors open and flaps down, VX158 is rolled out of the assembly hanger at Aldergrove. In the hanger the unassembled nose of the second SA.4 is visible. In fact, VX161's roll-out was a year away.











These Ministry of Supply photographs of VX158 were taken immediately after the aircraft was rolled out in August 1951 and prior to its first flight. By this time, however, the Valiant prototype had been flying for three months and was the subject of a 'super priority' programme.

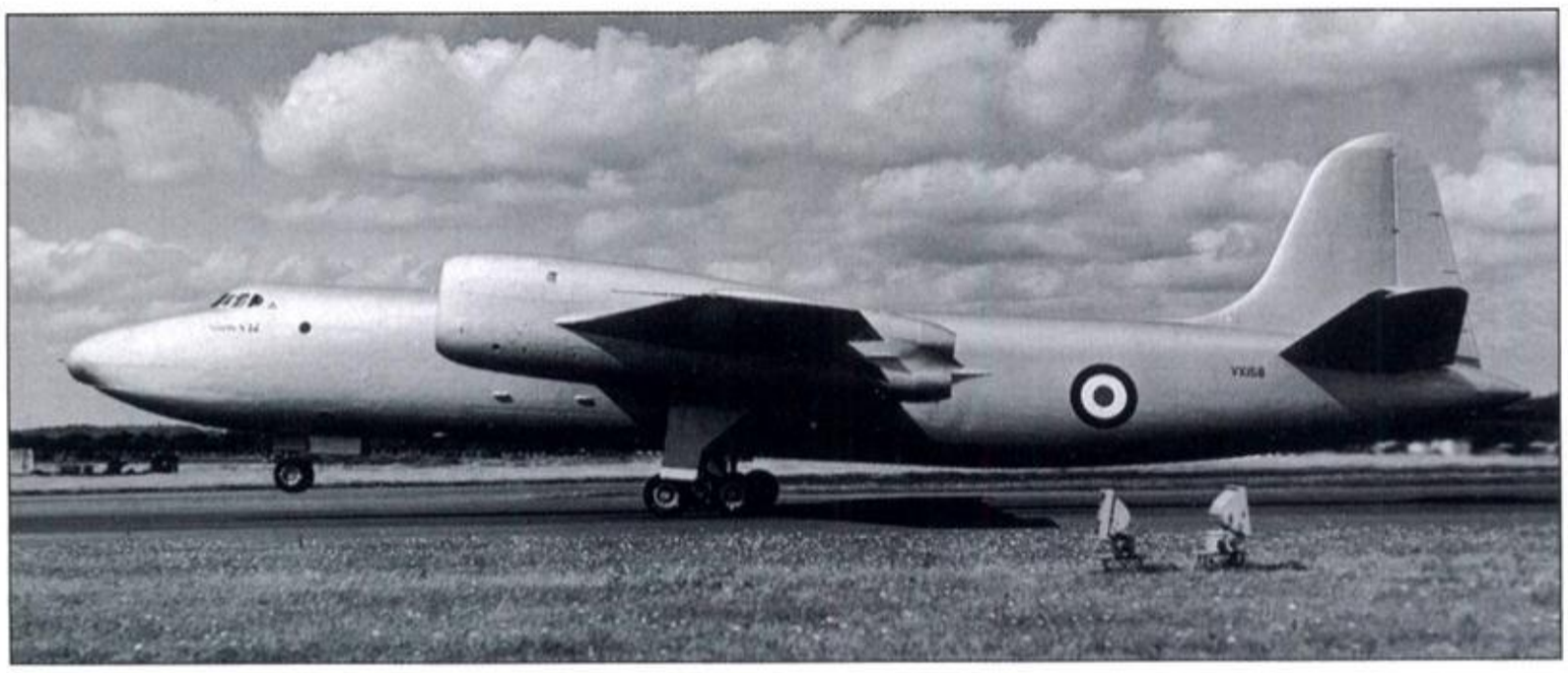
were appreciated by the Staff, and they therefore asked for an insurance design of lower performance which could be met with a conventional planform aircraft, and with which we could be sure of providing the RAF with a bomber to succeed the Lincoln."

In contrast to the normal procedure followed by the Ministry of Supply, no effort was made to approach other manufacturers with regard to the development of an 'insurance design'. Approval for simply placing the contract with Shorts was requested from the Under-Secretary of State for Air by the Controller of Supplies (Air), Air Marshal Sir Alec Coryton, on 24 December 1946. In response, the Under-Secretary stated: "In view of the fact that Shorts have already done so much work on this medium-range bomber, of the urgency of the requirement, and of the desirability of giving Shorts more design work as a bait to their technical staffs to move to Belfast, I agree that the contract should be placed with them without going out to competitive tender."

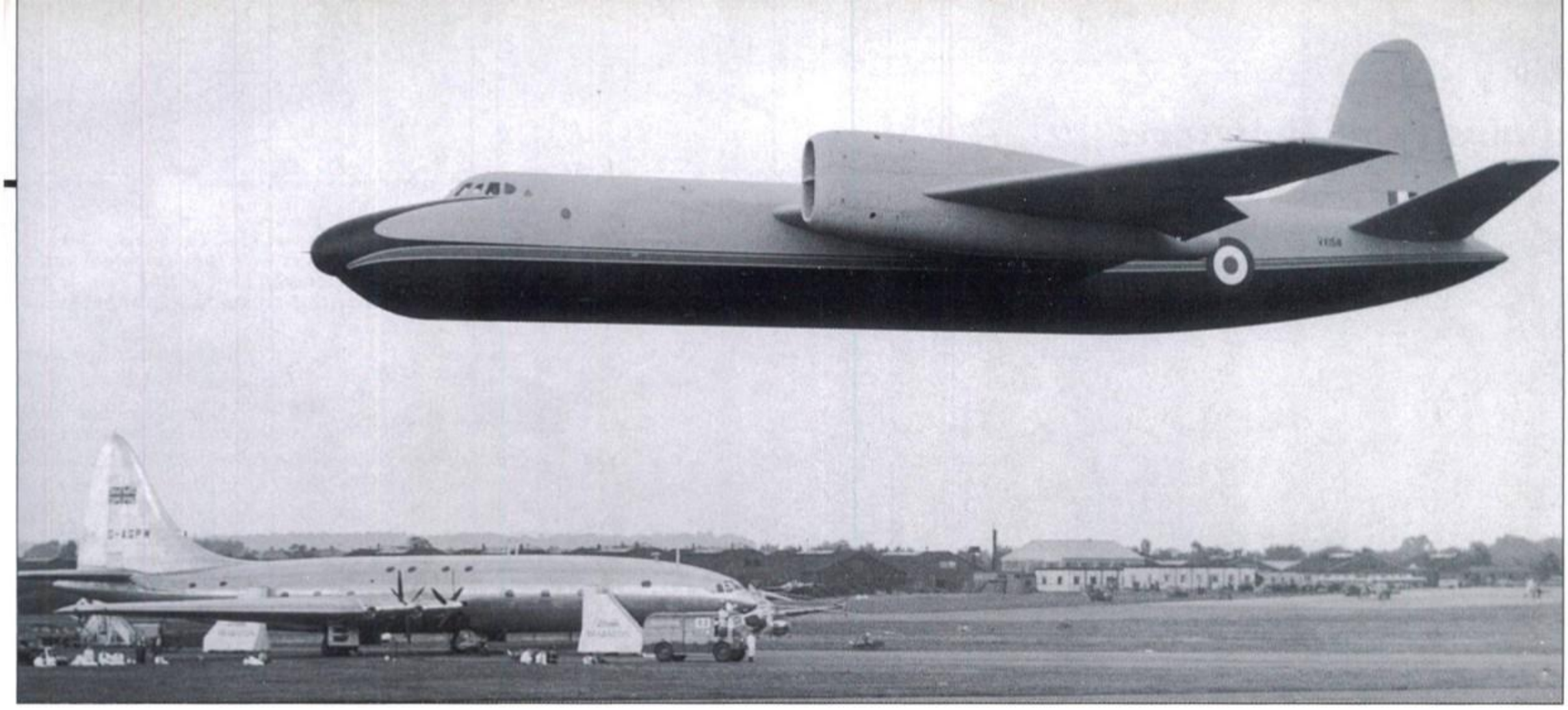
Operational Requirement 239

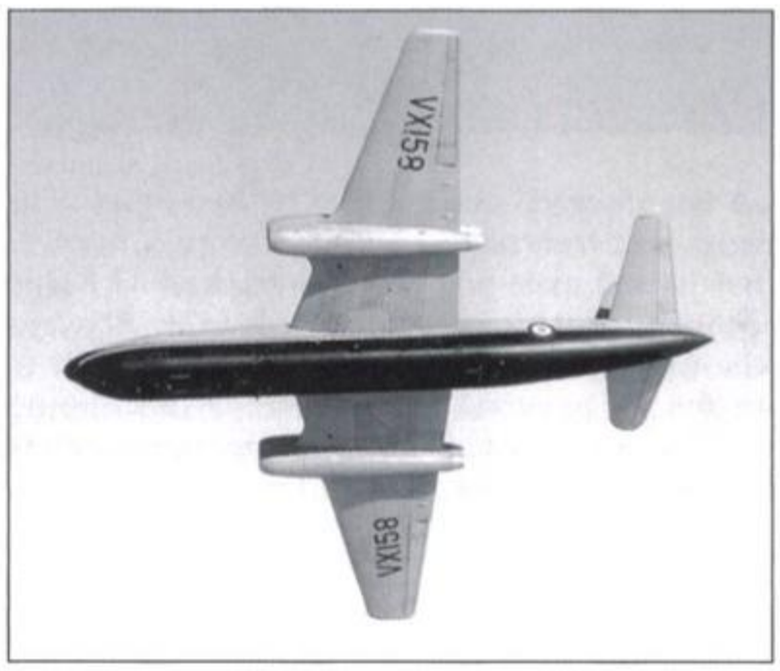
An Operational Requirement to cover the development of the Shorts 'insurance' bomber – Air Staff Requirement No. OR239: Medium Range Bomber 'Insurance' Aircraft – was released in January 1947. Acknowledging that OR229 laid out "details of a medium range bomber which they would like to have," the OR went on to note, "This requirement, however, is a severe one and will necessitate an aircraft with swept-back wings and other features which are at present somewhat unconventional and not proved. The Air Staff therefore requires an additional aircraft built as nearly as possible to Requirement No. OR229 but constructed on more or less conventional lines, so that it could go into service in the event of the more exacting requirement being held up for an undue length of time." In order to facilitate this, OR239 reduced the maximum cruise speed demanded from 500 kt to 435 kt (802 km/h) at high altitude and the maximum ceiling from 50,000 ft to 45,000 ft (13716 m). The minimum permissible standards for take-off performance and the ability to maintain height with one engine were also reduced. In order to permit the aircraft to operate from existing bomber airfields, the need to keep the maximum all-up weight of the aircraft to 120,000-140,000 lb (54432-63504 kg) was emphasised.

Discussions with regard to the development of Shorts' design to OR239 continued into 1947. Some consideration was given to the possibility



VX158 rotates from the Aldergrove runway for its first flight on 10 August 1951, with Tom Brooke-Smith at the controls. Any hope of a production contract had faded by this point, and the type was destined to be used purely as a test bed.





Bristol's Brabazon Mk I rests in the background of this view of a high-speed low-level pass by VX158 at Farnborough in 1951 (top). Both designs had been out-paced by the march of technology. With the XB-47 having flown in December 1947, the SA.4's layout (above) looked decidedly passé.

of employing turboprops to power the SA.4. However, analyses by the company and the Ministry of Supply concluded that no fewer than eight Bristol Proteus engines would be required to power the aircraft; even if this were practicable, the performance of a Proteus-powered SA.4 would be markedly inferior to that of the aircraft when powered by four AJ-65s.

One change that was made to the design centred not upon the type of engine to power the SA.4, but rather their location. In its brochure of December 1946, the company outlined three alternative installations for the AJ-65 jet engines, concluding that 'Design B' – positioning the engines in paired underslung nacelles outboard of the undercarriage – was that most worthy of further development. However, following discussions between Shorts, the Royal Aircraft Establishment (RAE) and Rolls-Royce, by June 1947 this layout had been rejected in favour of mounting the engines in pairs vertically above and below the wing. This novel installation was adopted in the belief that it would pose fewer difficulties in terms of the aircraft's critical Mach number; reduce aerodynamic forces on the engine cowls, thus enabling the weight of the installation to be reduced; cause less interference with the wing; and increase engine intake efficiency.

A more radical revision was discussed at a meeting chaired by the Director of Military Aircraft Research and Development (DMARD), J. E. Serby, on 28 July 1947. During the meeting, representatives from various departments of the Ministry of Supply and the RAE compared the SA.4 design with those advanced by English Electric and Vickers to the OR229 specification (B.35/46). Noting that the performance of the Vickers aircraft was superior to that of the SA.4 – largely due to its swept wings and more powerful projected Napier 131 engines – the meeting considered the possibility of redesigning the Shorts bomber to incorporate the Napier powerplants and wings swept to 20°-25°. However, this proposal was rejected on the grounds that such a redesign would result in a delay of one year to the programme, and involve the use of engines still in the very early stages of design.

Specification B.14/46 for the construction of the Shorts SA.4 to OR239 was officially issued by the Ministry of Supply on 11 August 1947 – although the designation B.14/46 would appear to have been in use for some time before this date. Following the finalisation of the SA.4 design, construction of three aircraft – two flying prototypes and a structural test airframe – began in production jigs at Shorts factory at Queen's Island, Belfast, in 1948. In keeping with the demands of OR239, the SA.4 was essentially of conventional aerodynamic design. Within the limitations of the Operational Requirement, however, Shorts did endeavour to build a number of innovative features into the aircraft.

The airframe was manufactured from the new DTD 687 aluminium alloy, and several processes were developed by Shorts during construction in order to achieve the finest possible surface finish. The SA.4's unswept wings were of AD7 symmetrical aerofoil section and were set at an incidence of 4° 30' and a dihedral of 1°. The leading edge of each wing was swept an angle of 18°. The wing was built around a box spar, formed from the front and rear girders; they were connected by sheet drag-members notched to accept spanwise stiffeners. Wing control surfaces included outboard ailerons with a deflection of 16° up and down, each of which was fitted with a tab. Additionally, each wing carried a flap each side of the engine nacelle, which could be deployed to 7°, 25° and 40° angles; an independent system was included to enable the flaps to be lowered to their maximum setting in the event of an emergency. Hydraulically-operated split airbrakes were also incorporated in each outer flap, opening above and below the trailing edge of the flap.

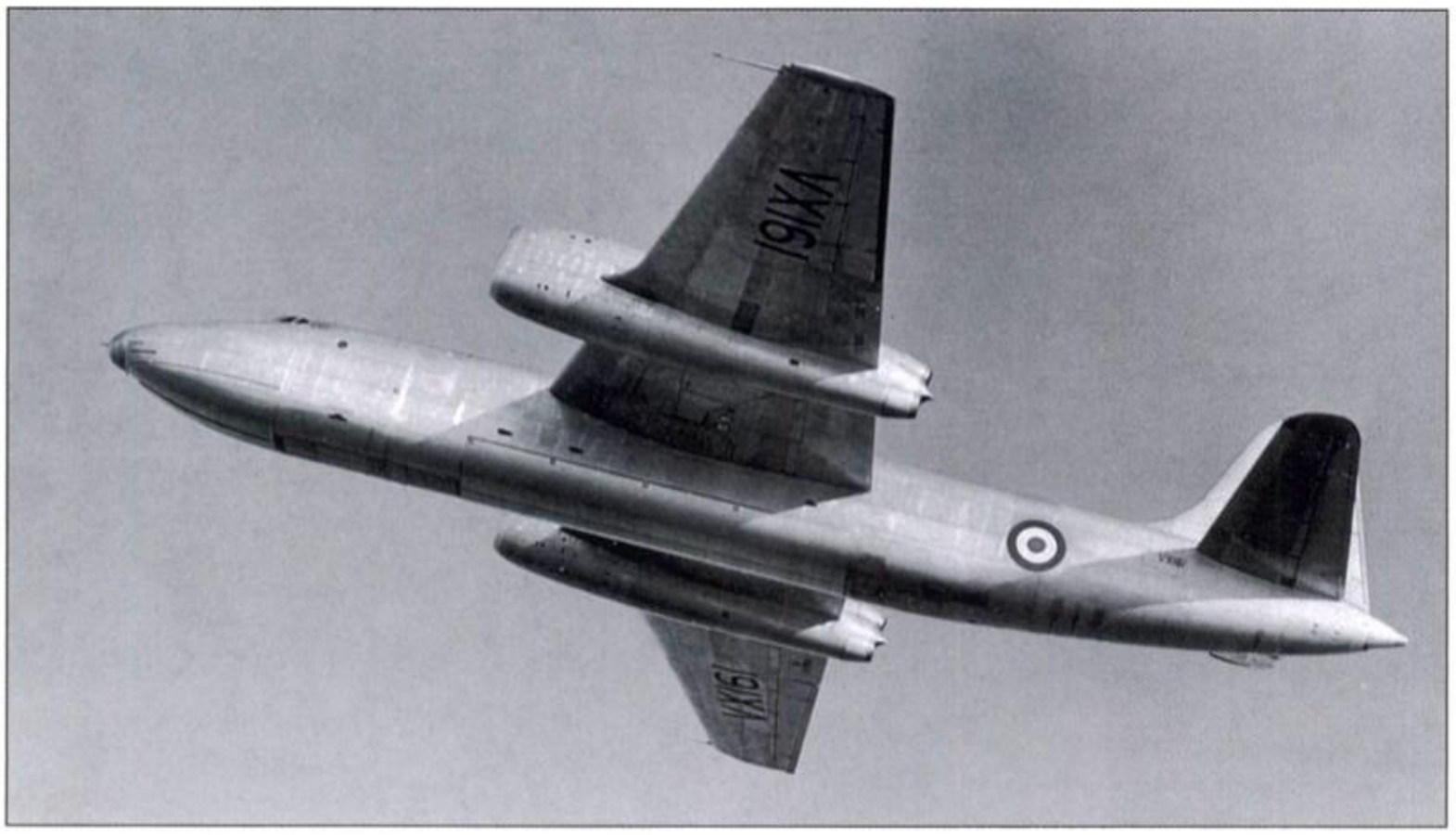
Sunderland test-bed

The SA.4 featured a non-powered servo flying control system, based on the use of irreversible screw-jacks which were driven by cables from the cockpit which actuated high aspect ratio servo tabs on the trailing edges of the main surfaces. Artificial feel was provided via a spring system. The elevator circuit also featured a pneumatic *g*-restricting stop in the elevator circuit, activated by the aircraft's indicated air speed. In order to evaluate this system in flight, the SA.4's fin and rudder unit was installed in a Sunderland Mk 5 (PP151), which was loaned to the company for this purpose in June 1949 and flew with the unit in place between November 1950 and May 1951.

As noted above, one of the most striking features of the aircraft was its novel engine installation. Two Rolls-Royce Avon RA.2 (first prototype VX158) or RA.3 (second prototype VX161) engines were mounted vertically above and below each wing in paired nacelles, positioned symmetrically to the wing chord line, the upper engine being slanted downward and the lower engine slanted upward in relation to the chord line. The rear halves of the jet pipes were bent in opposite directions; given a wing incidence of 4° 30' this had the effect of giving the upper jet pipe a downward slant, the lower pipe being approximately level. During the design, it had been proposed to include a hot-air de-icing system for the engine air intakes. While this proposal was later discarded, the nacelles were nevertheless widened by 12 in (30 cm) to accommodate the ducting required for such a system.

A total of 6,200 Imp gal (28185 litres) of fuel for the Avons could be housed in 22 non-rigid tanks. Seven of these were contained in each wing - three between the engine nacelle and the fuselage, and four outboard – holding a maximum of 1,610 Imp gal (7319 litres) per wing. Another eight tanks were in the fuselage – four forward (1,600 Imp gal/7274 litres maximum) and four aft (1,380 Imp gal/6273 litres maximum). The aircraft was normally fuelled using two receptacles in the fuselage sides at the rear of the bomb bay.

The SA.4 used a tricycle undercarriage manufactured by British Messier. The nosewheel consisted of a steerable castoring twin-wheel nose unit, which retracted to the rear in flight to lie in



First flown on 12 August 1952, the second SA.4 spent nearly four years with the Armament and Instrument Experimental Unit at RAF Woodbridge, dropping concrete bomb shapes.

an unpressurised box covered by two doors. The main undercarriage consisted of two massive four-wheel main bogies with a track of 32 ft 2 in (9.8 m), which retracted inwards to lie between the wing spars inboard of the engine nacelles. In order to prevent the undercarriage being accidentally retracted, a ram-air pressure switch in the undercarriage circuit ensured that the undercarriage could not be retracted until the aircraft was flying at a pre-set airspeed. The aircraft was brought to a halt by multi-plate brakes on the main landing gear, each being fitted with the Dunlop Maxaret anti-skid system.

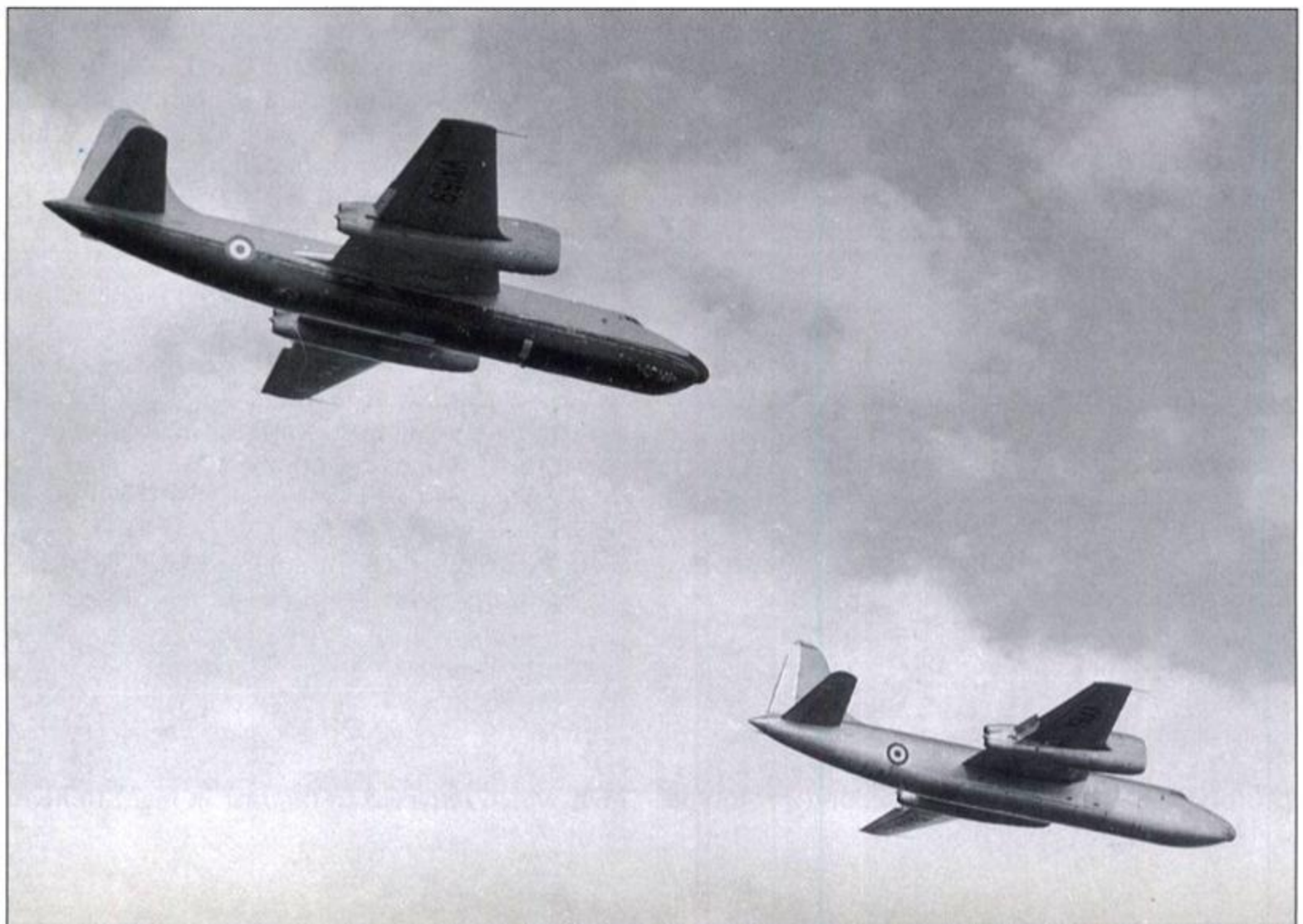
The fuselage was of semi-monocoque construction, employing a stressed skin over a framework of formers and stringers. It was constructed in three sections – nose, centre and rear – each of which ended with a double frame. The nose section incorporated a pressure cabin for the crew; a visual bomb-aimer's position, joined to the main pressure cabin by a tunnel; and a large radome for the aircraft's intended H2S Mk 9A navigation and bombing radar. The cabin was pressurised to an altitude of 8,000 ft (2438 m) by a fully duplicated pressurisation system, fed by a pair of two-stage superchargers driven from engine accessory gearboxes located at the leading edge of each wing.

The pressure cabin housed a crew of five. The pilot and co-pilot sat on the flight deck, facing forward; the bomb-aimer, navigator and radio operator sat at the rear of the cabin, facing backwards in front of a full-width table. Access to the cabin was gained via a tunnel which sloped forward from the belly of the aircraft to the pressure cabin. At one stage it was proposed that the cabin should be jettisonable, in order to act as an escape capsule in the event of an airborne emergency; however, the additional weight that this would entail, together with wind tunnel tests which demonstrated that the capsule would be unstable, led to this idea being dropped. Instead, in the event of an emergency the co-pilot and rear crew members would bail out manually via the main entrance tunnel. Only the pilot sat on an ejection seat; for structural reasons, this was required to tilt inward and to the rear before firing through a roof hatch. Provision was made for the carriage of a full range of emergency equipment, and an H Type Mk 3 dingy was stowed between the pressurised cabin and the forward fuel tanks.

Specification B14/46 called for the SA.4 design to make provision for an extensive electronics suite. The heart of this system was to be the aircraft's integrated Navigation and Bombing System (NBS). Information from the aircraft's H2S Mk 9A radar and other sources was processed by the Navigation and Bombing Computer (NBC) to provide continuous automatic dead-reckoning of the aircraft's ground speed, drift and ground position; bombing data was also to be generated on a radar display or a visual bombsight for the bomb-aimer. Additionally, the aircraft was to carry Rebecca/BABS (Blind Approach Beacon System) or SCS.51 landing aids; high-altitude radio altimeters; an automatic radio compass; W/T and multi-channel VHF radios; a radio-teleprinter with automatic encryption; and a cloud and collision warning system. Space was also to be made to allow electronic protection and jamming equipment to be carried if and when they became available, including a tail warning radar covering a cone 45° from the rear of the aircraft, a system for prematurely detonating missile proximity fuses and 'window' (chaff) launchers.

The centre section of the aircraft was dominated by the bomb bay. Designed to be capable of carrying the atomic weapon then under development to Operational Requirement OR1001 – codenamed Blue Danube – the bomb bay occupied the entire cross-section of the fuselage below the wing, being some 30 ft 3 in (9.2 m) long and having a capacity of 996 sq ft (93 m²). A pair of hydraulically-operated doors covered this expanse. In keeping with its future role of a weapons trials aircraft, SA.4 VX161 was able to load weapons into the bomb bay using an external crane, the cables for which passed through hatches in the upper fuselage. Immediately behind the bomb bay was a camera bay, the doors of which were designed to open either independently or in parallel with those of the bomb bay; the doors were then closed using a separate switch. The rear section of the aircraft carried a conventional tail unit. It also accommodated a braking parachute system, consisting of an auxiliary parachute, retarder parachute and two main canopies.

Both Short SA.4s formate in late 1952 on a sortie from Aldergrove. VX158 is still wearing the airshow scheme applied for its first Farnborough show the previous year, while VX161 is in the natural metal finish worn throughout its life.



From bomber to testbed

Even as preparations for the construction of the first prototypes got underway, concerns began to mount within the Air Staff about the ability of the SA.4 to fulfil the role of an interim strategic bomber. At a Design Study Conference on 15 January 1948, the Principal Director of Technical Development (Air), S. Scott-Hall, noted that, following the decision in July 1947 to order the SA.4 as an insurance policy against the failure of the designs being pursued by Avro and Handley Page, "It had later been decided that the importance of the bomber was such that a further type must be ordered in between these two extremes."

By September 1952 VX158 was back in its original natural metal finish, though it retained its original nose profile and had yet to be fitted with nose glazing.

Specification

Crew: five (pilot; co-pilot; navigator; bomb-aimer; radio operator)
Powerplant: (VX158, as manufactured) four 6,000-lb (26.60-kN) static thrust Rolls Royce Avon RA.2 turbojet engines; (VX161, as manufactured) four 6,500-lb (28.91-kN) static thrust Rolls-Royce Avon RA.3 turbojet engines; (VX158, as modified) two Rolls-Royce Avon RA.3 turbojet engines and two two 15,000-lb (66.73-kN) static thrust de Havilland Gyron D.Gy.1 engines; Avons later replaced by two 20,000-lb (88.97-kN) static thrust de Havilland Gyron D.Gy.2 engines
Dimensions: span 109 ft (33.2 m); length 102 ft 2 in (31.14 m); height 28 ft 6 in (8.69 m); wing area 1896.72 sq ft (176.21 m²); wheel track 32 ft 2 in (9.8 m)
Weights: empty 72,000 lb (32659 kg); maximum all-up 115,000 lb (52163 kg)
Performance: (VX161, as manufactured) maximum level speed 492 kt (567 mph; 912 km/h) true air speed at 15,000 ft (4572 m); cruising speed 435 kt (501 mph; 806 km/h) true air speed at 40,000 ft (12192 m); climb rate 8.04 minutes to 25,000 ft (7620 m); recommended climb speed 250 kt (288 mph; 463 km/h) indicated air speed; service ceiling 45,000 ft (13716 m); maximum range 2,780 nautical miles (3201 miles; 5151 km) at 395 knots (455mph; 732 km/h) true air speed

Designs for interim aircraft advanced by Vickers and English Electric were seen as possible contenders for this order.

Of the latter, the Vickers 660 was eventually selected for production, a contract being placed for the construction of two prototypes on 2 February 1949. Although work on the SA.4 continued, it was clear that the successful development of the Vickers 660 (later to be christened Valiant) would render the Sperrin unnecessary. Accordingly, in March 1950 the Ministry of Supply informed the Treasury that further expenditure on the Sperrin as a combat aircraft could not be justified. Despite this, however, construction of both prototypes as flight test aircraft was authorised to continue, and a revised issue of B.14/46 calling for the prototypes to be suitably modified for trials work was approved by the Ministry of Supply on 12 October 1950.

First flight

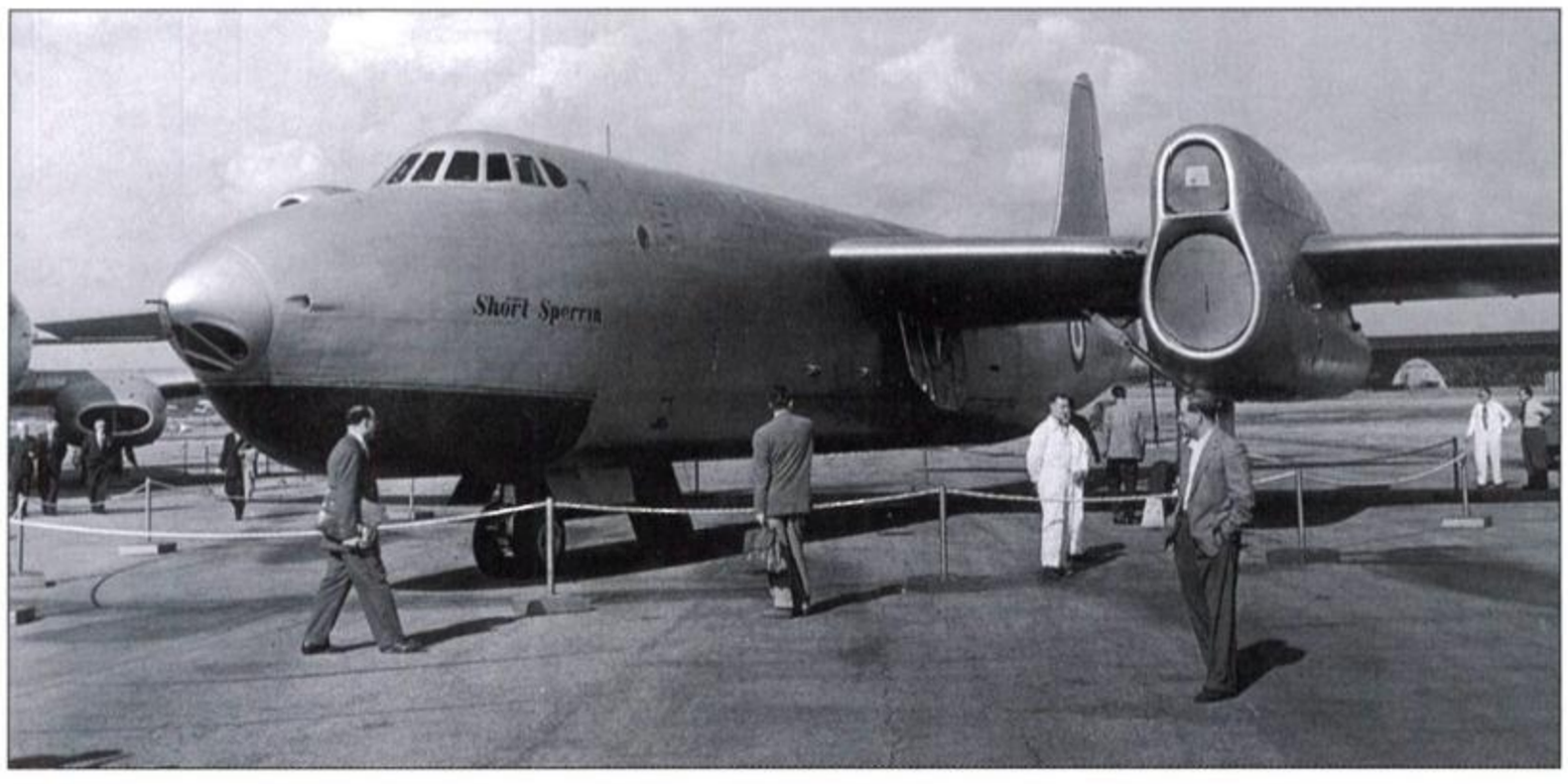
A series of production delays during the winter of 1950-51 delayed the SA.4 programme, and it was not until 6 August 1951 that taxiing trials commenced at RAF Aldergrove - the first prototype, VX158, having been moved by road from the Shorts factory at Queens Island to Aldergrove due to concerns about the length of the factory runway at Sydenham. Following a further delay to enable onboard equipment to be inspected and calibrated, taxiing runs were resumed on 9 August; during one, VX158 become airborne for a distance of 80 yd (73 m). The braking parachute was also successfully streamed. Unfortunately, during these tests, the underside of the aircraft came into contact with the ground, damaging the frames located at the elevator front spar.

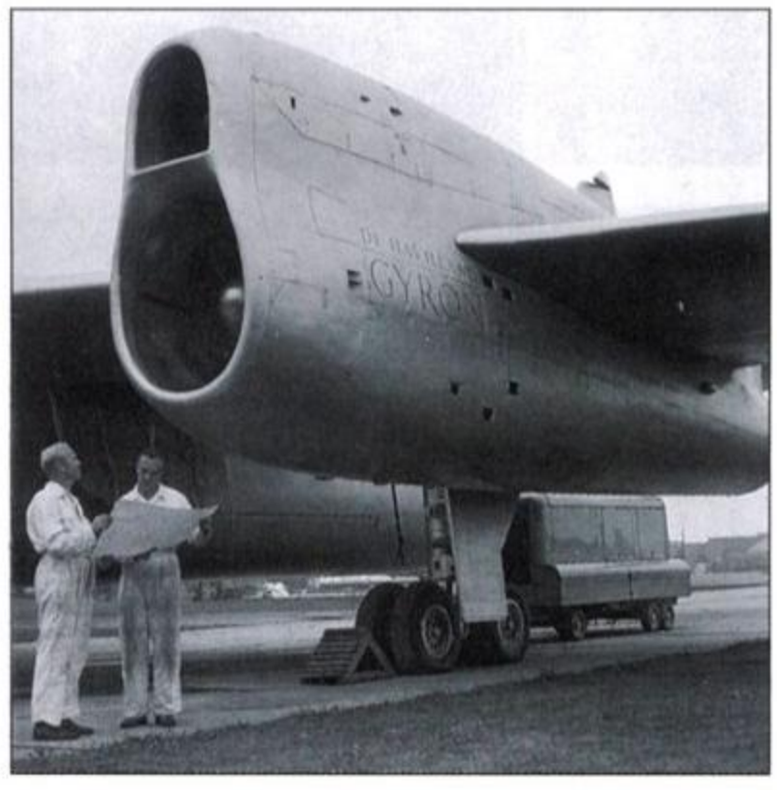
Repairs to VX158 were completed by 5:30 p.m. on 10 August and a final low-speed taxi test was carried out. The aircraft was then refuelled in preparation for its first flight, and at 8:18 p.m. Shorts' chief test pilot, Tom Brooke-Smith, lifted the SA.4 off the runway at RAF Aldergrove, rotation at 105 kt (194 km/h) being achieved following a take-off run of approximately 400 yd (366 m). During the maiden flight, VX158 successfully completed the scheduled low-speed control tests, returning to Aldergrove some 24 minutes after take-off.

The preliminary flight test programme of the new bomber was interrupted when VX158 participated in the 1951 Society of British Aircraft Constructors (SBAC) show at Farnborough. Following its maiden public appearance, the first prototype returned to Aldergrove to continue manufacturer's flight trials in the hands of Tom Brooke-Smith and his deputy, Walter 'Wally' Runcimann. This trials programme was subsequently transferred to the company airfield at Sydenham following the extension of that facility's main runway. The aircraft proved easy both to fly and to maintain. Only minor difficulties were

VX158 was exhibited again at Farnborough in 1955, promoting the DH Gyron engine, a single-example being installed in the lower port nacelle. Note the name 'Short Sperrin' had, by this stage, been painted on its nose.

Subject to a Ministry of Supply development contract, the axial-flow de Havilland Gyron ran for the first time on 5 January 1953, with an initial thrust rating of 15,000 lb (66.1 kN) thrust. Gyron flight testing on the Sperrin started on 7 July 1955.





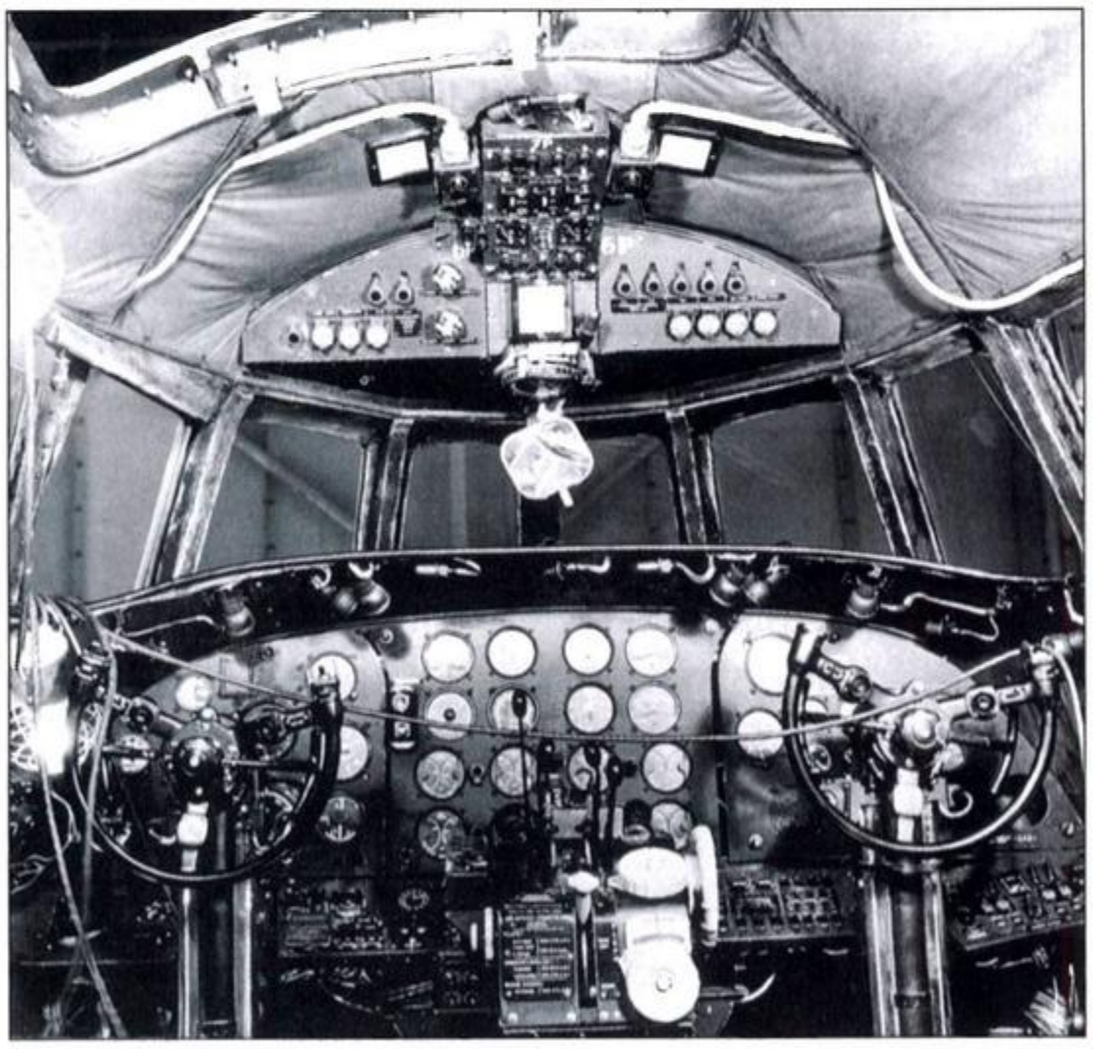
After testing the single initial-rated Gyron, a 20,000-lb (88.95-kN) Gyron D.Gy.2 was fitted into each lower nacelle. Cancellation of the P.1121 fighter (which was to to be powered by a pair of Gyrons with reheat) in the 1957 Defence White Paper brought a halt to Gyron research.

encountered during flight testing, although aileron flutter above 42,000 ft (12802 m) did prevent the design Mach number of 0.85 being achieved.

Tests and trials

Following the completion of manufacturer's trials in May 1953, the aircraft was delivered to the RAE at Farnborough to participate in testing of the Navigation and Bombing System to be carried by aircraft of the 'V-Force'. Trials completed, in January 1954 the aircraft was returned to Shorts, subsequently being prepared for the new role of engine testbed. On 7 July 1955 VX158 flew from Aldergrove for the first time with a mighty 15,000-lb (66.1-kN) thrust de Havilland Gyron D.Gy.1 in a heavily modified lower port engine nacelle, piloted by Shorts' test pilot Jock Eassie and de Havilland Engine Company chief test pilot C. D. Beaumont. VX158 was allotted to de Havilland for flight testing on 29 July and left Aldergrove for Hatfield on 4 August, returning to Sydenham to have a pair of 20,000-lb (88.95-kN) thrust Gyron D.Gy.2 engines installed in the left and right lower nacelles on 4 December 1955. The aircraft first flew in that configuration on 26 June 1956; during the course of this flight an undercarriage door was lost over the sea, a replacement being taken from sister aircraft VX161, now in storage at Shorts (see below).

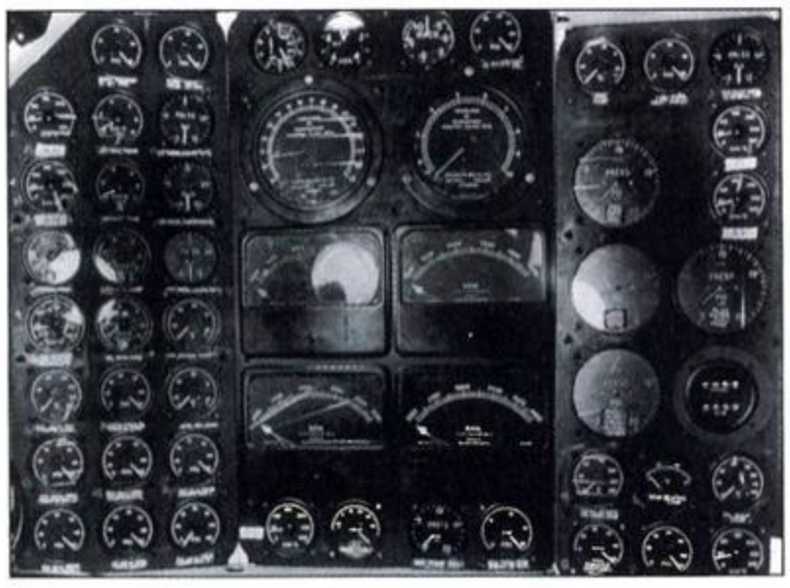
Following a final appearance at Farnborough, VX158 returned to Hatfield to carry out further trials of the Gyron, including measurement of the engine's infra-red signature by de Havilland's missile arm, de Havilland Propeller Company. Sadly, cancellation of the Gyron programme would appear to have brought the useful life of VX158 to a close; efforts to sell the aircraft to de Havilland came to nought, and it subsequently went for scrap sometime after mid-1960.

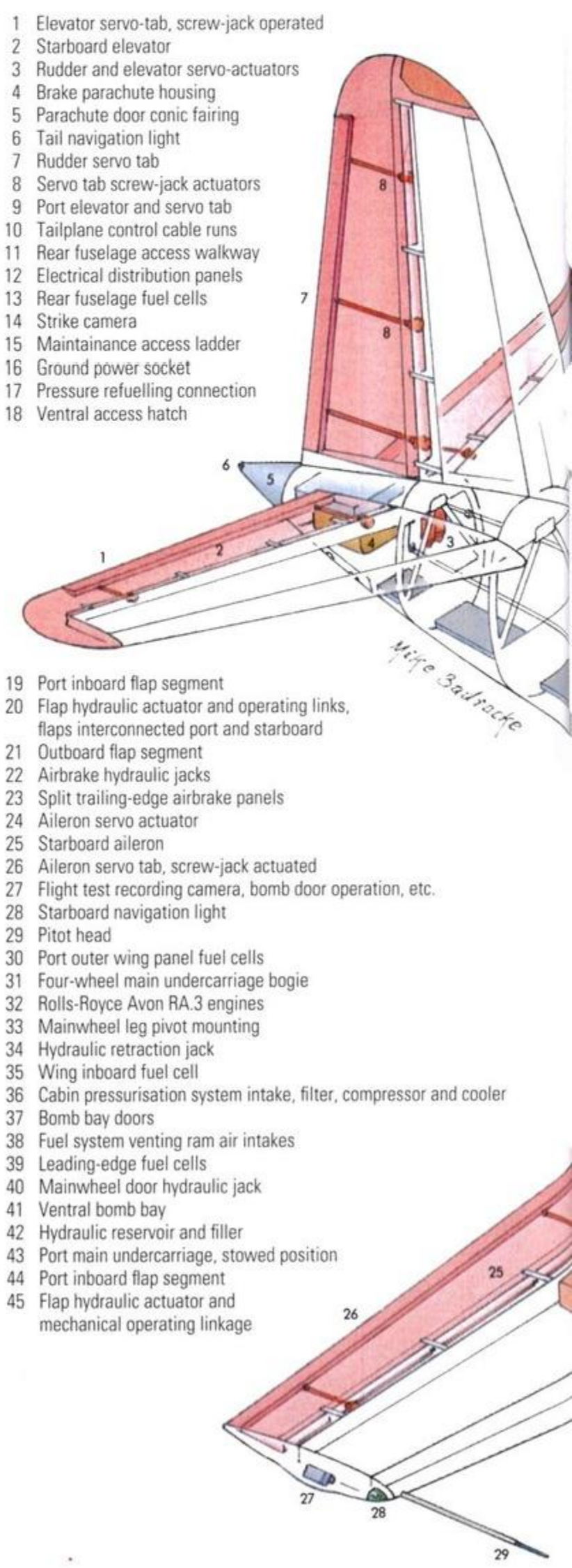


Left: The Sperrin's very conventional cockpit layout was fairly typical of a large bomber aircraft of its time and managed to give little clue that the aircraft was supposedly modern and jet-powered.

Below left: This is the flight engineer's cockpit display, dominated in the centre by the rectangular engine RPM dials.

Below: This view of VX158 shows the unconventional double-engine layout and exhausts, wheel-bay doors and the aircraft's generous flap area to good advantage. The outer flap contained the split trailing edge airbrakes. The Sperrin's engine nacelles were 12 in (30 cm) wider than they needed to be; a planned intake de-icing system was abandoned, but not before allowances had been made in the nacelles' design for the system's plumbing.




1 Elevator servo-tab, screw-jack operated
2 Starboard elevator
3 Rudder and elevator servo-actuators
4 Brake parachute housing
5 Parachute door conic fairing
6 Tail navigation light
7 Rudder servo tab
8 Servo tab screw-jack actuators
9 Port elevator and servo tab
10 Tailplane control cable runs
11 Rear fuselage access walkway
12 Electrical distribution panels
13 Rear fuselage fuel cells
14 Strike camera
15 Maintainance access ladder
16 Ground power socket
17 Pressure refuelling connection
18 Ventral access hatch
19 Port inboard flap segment
20 Flap hydraulic actuator and operating links, flaps interconnected port and starboard
21 Outboard flap segment
22 Airbrake hydraulic jacks
23 Split trailing-edge airbrake panels
24 Aileron servo actuator
25 Starboard aileron
26 Aileron servo tab, screw-jack actuated
27 Flight test recording camera, bomb door operation, etc.
28 Starboard navigation light
29 Pitot head
30 Port outer wing panel fuel cells
31 Four-wheel main undercarriage bogie
32 Rolls-Royce Avon RA.3 engines
33 Mainwheel leg pivot mounting
34 Hydraulic retraction jack
35 Wing inboard fuel cell
36 Cabin pressurisation system intake, filter, compressor and cooler
37 Bomb bay doors
38 Fuel system venting ram air intakes
39 Leading-edge fuel cells
40 Mainwheel door hydraulic jack
41 Ventral bomb bay
42 Hydraulic reservoir and filler
43 Port main undercarriage, stowed position
44 Port inboard flap segment
45 Flap hydraulic actuator and mechanical operating linkage
Mike Badrocke

VX161 arrived at Short's Sydenham facility from Farnborough in mid-1956. Destined never to fly again, it donated an undercarriage fairing door to VX158, before being scrapped.

The Woodbridge Project

The second prototype, VX161, made its maiden flight from Aldergrove on 12 August 1952. Completed without the NBS system, following manufacturer's trials it also commenced its career as a test aircraft, being allotted to the Armament and Instrument Experimental Unit – a joint RAF/RAE unit – at RAF Martlesham Heath. The aircraft was actually operated from RAF Woodbridge, its first duty being to conduct what was known as the Woodbridge Project: top-secret loading and ballistic trials of the casing for Britain's first atomic weapon, Blue Danube, under the direction of the Armament Research Establishment at Fort Halstead in Kent. For these trials, the aircraft was operated for the RAF by ground and aircrew provided by Shorts under contract. Subsequently, VX161 was also used to test other weapons, including the Blue Boar TV-guided bomb. Shortly before this work came to an end, the SA.4 was named Sperrin, after a range of mountains in Northern Ireland. Finally, on 3 July 1956 VX161 was allotted to Shorts at Belfast, to be placed into temporary storage pending a decision as to whether the aircraft should be put through major servicing or scrapped; the aircraft never flew again, being sold to John Eastwood Ltd of Belfast on 2 June 1958. **Clive Richards**

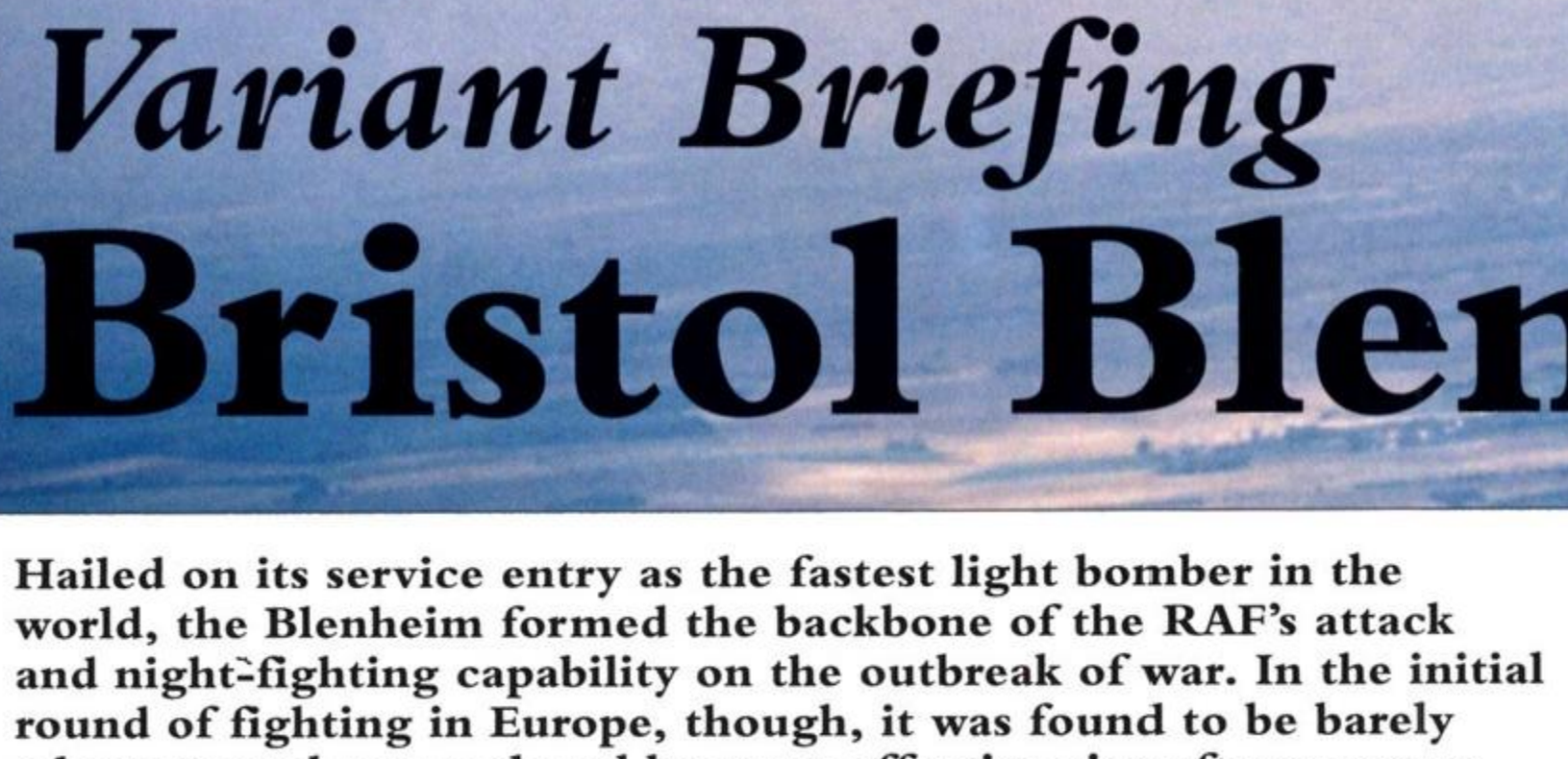
Short SA.4 Sperrin (VX158) cutaway drawing

46 Jet pipes and exhaust fairing
47 Port split trailing-edge airbrakes
48 Port outboard flap segment
49 Port aileron and servo tab
50 Wing tip camera mounting
51 Port navigation light
52 Pitot head
53 Port wing outboard fuel cells
54 Port upper Rolls-Royce Avon R.A.3 engine
55 Gearbox angled drive shaft
56 Auxiliary gearbox and generator
57 Port lower de Havilland Gyron D.Gy. 1 engine, flight test installation
58 Port pressurisation system equipment
59 Inboard and leading-edge fuel cells
60 Forward fuselage fuel cells
61 VHF communications antenna
62 Port side dinghy hatch
63 Ejection seat positioning spring unit
64 Dinghy stowage
65 Crew compartment pressurised capsule
66 Oxygen bottles
67 Bomb bay door hydraulic jack
68 Electrical equipment bay, inverters and suppressors
69 Ventral entry/escape hatch and sloping tunnel
70 Cabin air conditioning pack
71 Entry hatch pressure door
72 Radar operator's station
73 Navigator/bomb-aimer's station, folding chart table and seat give access to entry/escape hatch
74 Radio operator'station
75 Election hatch
76 Overhead panel, warning lights and extinguisher controls
77 Pilot's Martin-Baker ejection seat
78 Co-pilot's fixed seat
79 Instrument panel
80 Control column and rudder pedals
81 Nose undercarriage hydraulic retraction jack
82 Twin nosewheels, aft retracting
83 Ventral radome
84 H2S radar scanner
85 Radar and electrical equipment cooling ram air duct
86 Oxygen bottles
87 Pressurised tunnel to bomb aiming position
88 Bomb-aimer's prone position
89 Bomb sight
90 Ventral bomb-aiming windows

Variant Briefing
Bristol Blenheim

Hailed on its service entry as the fastest light bomber in the world, the Blenheim formed the backbone of the RAF's attack and night-fighting capability on the outbreak of war. In the initial round of fighting in Europe, though, it was found to be barely adequate and was replaced by more effective aircraft as soon as possible. However, it went on to compile a successful combat record in the Mediterranean and Far East.

Many aircraft types are surrounded by 'legends' that differ quite markedly from the truth. One such type was the Blenheim. The conventional wisdom has often been that the Blenheim represented a radical and revolutionary design concept. This conventional view also holds that the type was adopted by a backward-looking and reactionary Air Staff only when the aircraft's obvious advantages were demonstrated by a private venture prototype ordered as a high-speed transport by a patriotic newspaper tycoon. In service, before the war, the Blenheim is usually represented as having marked a huge leap forward – able to show any RAF fighter a clean pair of heels. As a warplane in front-line service during 1939-1942, the Blenheim is often



Progenitor of the Blenheim, the Bristol Type 142* Britain First *was the result of a private order for a commercial transport from a wealthy and patriotic newspaper magnate. The 142's performance immediately grabbed the attention of the Air Ministry, resulting in an extended period of loan (and eventual gifting) of the aircraft for military evaluation.

Left: Painstakingly restored from various Bolingbroke Mk IV-T components, this machine flies from Duxford as a fitting tribute to the many aircrew who flew the Blenheim into battle.

Factory-fresh Mk Is await flight test outside the Filton works. Large-scale production of the Blenheim allowed Bomber Command to expand rapidly as the war approached.

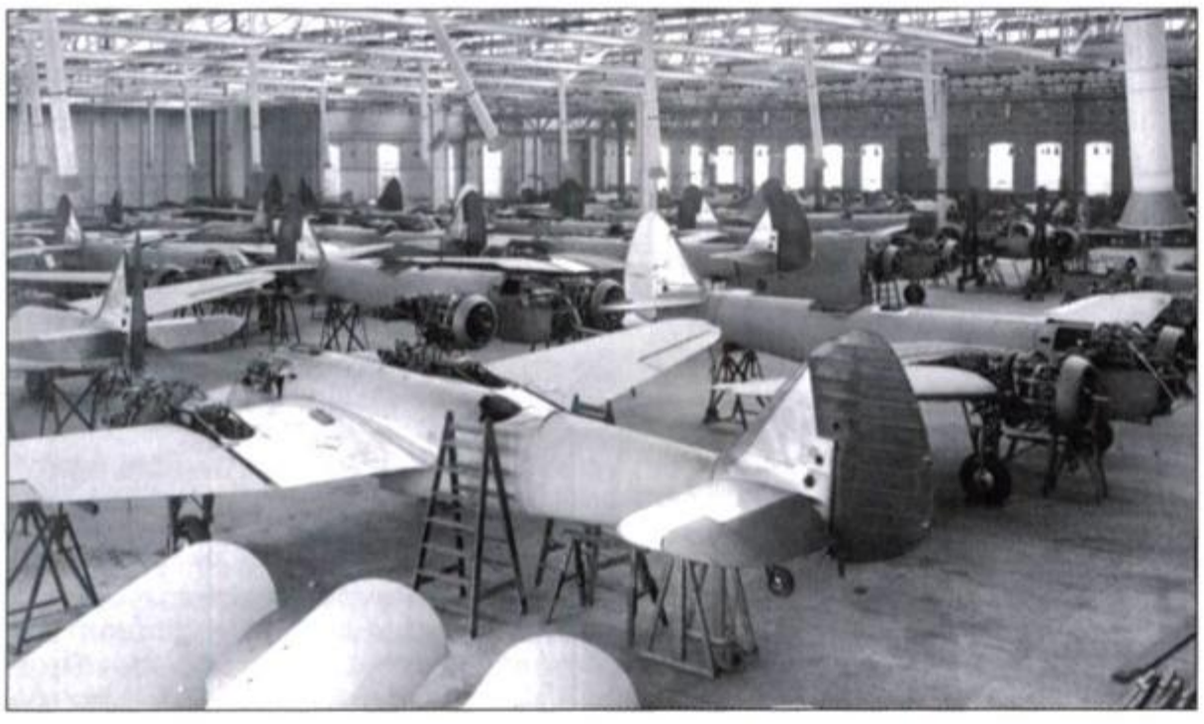
depicted as having been a fairly unmitigated disaster, being cut down in droves with effortless ease by enemy fighters. The aircraft is usually described as having achieved little, other than the pointless sacrifice of its crews, until better light bombers quickly replaced it. These were aircraft like the Boston, Mitchell and Mosquito, all of which were genuinely modern and genuinely capable.

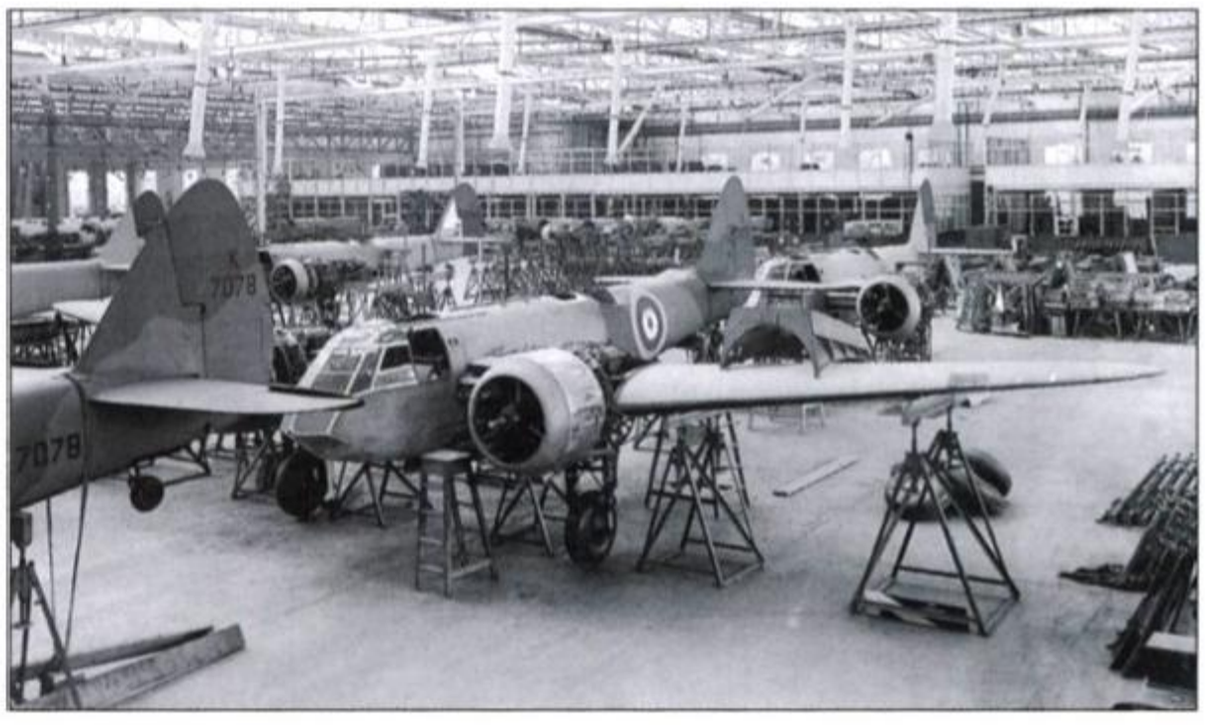
But this is an oversimplistic picture. Even before the original Bristol 142 made its maiden flight on 12 April 1935, the RAF had issued an April 1933 Specification for a high-speed monoplane day bomber (resulting in the Fairey Battle) and another (resulting in the Hawker Henley) in 1934. The Blenheim itself was actually ordered in August 1935. The service was thus not blind to the advantages of modern, all-metal monoplane design features, and was aware of the shortcomings of its existing biplane types. The RAF was already working quite hard to re-equip its squadrons with just this type of aircraft. The Blenheim did have far better performance characteristics than the Hawker Hart (and the Hind, which did not fly until September 1934 and entered service in December 1935), but it was not a revolutionary design foisted on backward-looking and resisting Air Marshals.

Realistic performance figures

Although the Blenheim was ordered 'off the drawing board', and though there was a brief period during which the Blenheim could theoretically out-pace the RAF's front-line fighters, it was a relatively modest and conventional aeroplane, rapidly outclassed by the new generation of monoplane fighters, and not nearly as impressive as the press made out at the time. Although the Blenheim had a theoretical maximum speed of 260 mph (418 km/h), it cruised at only 200 mph (321 km/h), and flew even more sedately when carrying external bombs, maximum internal bombload or when fully laden. A 260-mph bomber was quite an eye-opener, but a 200-mph bomber was less impressive (14 mph; 23 km/h faster than the Hind and about 30 mph; 48 km/h slower than the Gauntlet biplane fighter). And a 180-mph (290-km/h) bomber (which the Blenheim often was) was quite simply inadequate. The Blenheim cruised only 12 mph (19 km/h) faster than the anachronistic Vickers Wellesley, which carried double the bombload, and whose geodetic construction probably made it more resilient to enemy fire. Nor was the Blenheim a very good peacetime stopgap to equip the cadre around which Bomber Command expanded to its wartime strength. The aircraft was, admittedly, delightful to fly in good weather and when everything was going right. While the Blenheim was modern enough to provide problems for ground crew used to fabric-covered biplanes, and to aircrew unused to twin-engine handling quirks (with an engine out, the Blenheim was lethal), it was not modern enough to be representative of the types which would form

Two views in the Bristol works at Filton show early Blenheim Mk Is under construction. A.V. Roe at Chadderton and Rootes Securities at Speke also contributed large numbers of Blenheims.





Above: Using low-level tactics greatly increased the Blenheim's survivability, denying opposing fighters the chance of an attack against the bomber's unprotected belly. This trio of No. 21 Squadron aircraft heads across the Dutch countryside towards its target in Rotterdam on 16 July 1941.

Left: A Blenheim Mk IV from an operational training unit (hence the two-number code) demonstrates a low-level attack.

Bomber Command's wartime backbone, with their much larger crews and multiple powered gun turrets. In many ways, the fabric-covered Wellington (and even aircraft like the Wellesley and Whitley) provided a better introduction to the later 'heavies' than did the Blenheim.

The RAF's Specification B.28/35 which resulted in the Blenheim had not been sufficiently far-reaching or ambitious, and the need for the Blenheim to operate from existing grass airfields prevented Bristol from producing the 'British Ju 88' – instead, it produced a much less powerful aircraft carrying a tiny bombload, inadequately armed and inadequately armoured, and with more emphasis placed on field performance than flat-out speed. Aircraft like the Ju 88 and Do 17 – or the Baltimore, Boston, Maryland and Ventura – showed what was possible by using massive two-row radial engines and by accepting longer take-off and landing distances and the need for concrete runways. All these aircraft made the Blenheim look extremely unimpressive, as they carried much heavier bombloads over longer ranges at similar or higher speeds.

If there was a place for an aircraft with a 1,000-lb bombload, that aircraft should have been a fighter-bomber in the mould of the Westland Whirlwind, which carried a Blenheim-sized bombload over a 720-mile (1158-km) range but which was faster than the Spitfire Mk I or Bf 109E at some altitudes. Even with its immature and underdeveloped Peregrine engines, the Whirlwind proved remarkably effective and relatively invulnerable to enemy fighters. With Merlins installed it might have been better yet, but even in its original form, the aircraft could have been a war-winner had it been available in larger numbers. It would be tempting to imagine the results had squadrons of Whirlwinds been sent out *en masse* against targets where scores of Blenheims were lost, to little effect. Even when a Whirlwind was shot down, it took with it a single pilot (who was more easily able to abandon his aircraft and survive) and not a three-man crew.

In truth, there was little about the Blenheim that could really be described as modern. The aircraft entered service with no armour protection for its crew, a single forward-firing Browning and a single turret-mounted Vickers gun for self-defence, an old-fashioned and unreliable oxygen system, inadequate blind-flying equipment, primitive and near-obsolete radios and navigation equipment, and a lack of efficient heaters for the crew.

Blenheim losses

During the first year of the war, many Blenheims were lost because they were 'sitting ducks' to enemy fighters, and more fell when their crews suffered anoxia, when they got completely lost, or when they lost concentration as they froze in the bitter cold. Other aircraft stalled and spun when they became iced-up at high altitude; many Blenheims simply failed to return, the cause of their disappearance remaining a depressing mystery. Even when Blenheim aircrew succeeded in overcoming these difficulties, the aircraft carried a light load of outdated and largely ineffective bombs (with a very low charge-to-weight ratio), and aimed them using a primitive and inaccurate sight. The chances were remote that the tiny number of bombs that actually hit their targets would explode, and the weapons were so small that a direct hit or a very near miss was absolutely essential, even if they did work as advertised.

Yet, while the Blenheim was neither as good or as advanced as legend suggests in the late

The burnt-out remains of a No. 57 Squadron Blenheim Mk IV sit among French MS.406s at an airfield in France, while a Luftwaffe Bf 109E lands in the background. During the French campaign the Blenheim was found to be highly vulnerable in the day-bomber role when not provided with an effective fighter escort.

Blenheims in service, 1937–43

Pre-Munich Mk I
Before the Munich crisis Blenheims wore squadron numbers on the side, but these and other colourful markings subsequently disappeared. This aircraft is seen how it appeared in March 1937, when No. 114 Squadron re-equipped with the Mk I at Wyton to become the first user of the type, then considered the fastest medium bomber in the world.

Far East Mk V
No. 42 Squadron, which flew this Mk V from Kumbhirgram in India, was one of the last squadrons to use the Blenheim in a front-line role, giving up its aircraft in favour of Hurricane Mk IIC fighter-bombers in October 1943. This roundel style was adopted to avoid confusion with Japanese aircraft.

1930s, it was not as unsuccessful or as useless as some would infer once it went to war. By comparison with the Fairey Battle, for example, the Blenheim looked very good indeed, and did suffer very much lighter casualties. A Blenheim flew the first RAF sortie of the war (a reconnaissance of Wilhelmshaven mounted by a No. 139 Squadron Blenheim Mk IV, from Wyton) and on the outbreak of war the RAF had 168 Blenheim Mk IVs on charge, spread between 16 Bomber Command squadrons, and other units based overseas or with other Commands. Although the Blenheim did suffer heavy losses during the Battle of France and over the Low Countries, it was still able to operate in daylight, raiding targets (usually peripheral) in occupied Europe when every other RAF bomber type was forced to rely on the cloak of darkness. The Blenheim remained at the 'tip of the spear' with No. 2 Group until August 1942, when the Boston and Ventura took over, pending the introduction of the marvellous Mosquito. During its brief front-line career, the Blenheim flew more operational missions than were amassed by the Short Stirling during the whole of the war, and the type dropped a higher tonnage of bombs on the enemy than did the larger Avro Manchester. Moreover, the aircraft continued to give useful (if costly) service overseas long after it had been relegated from front-line use in European skies.

Fighter adaptations

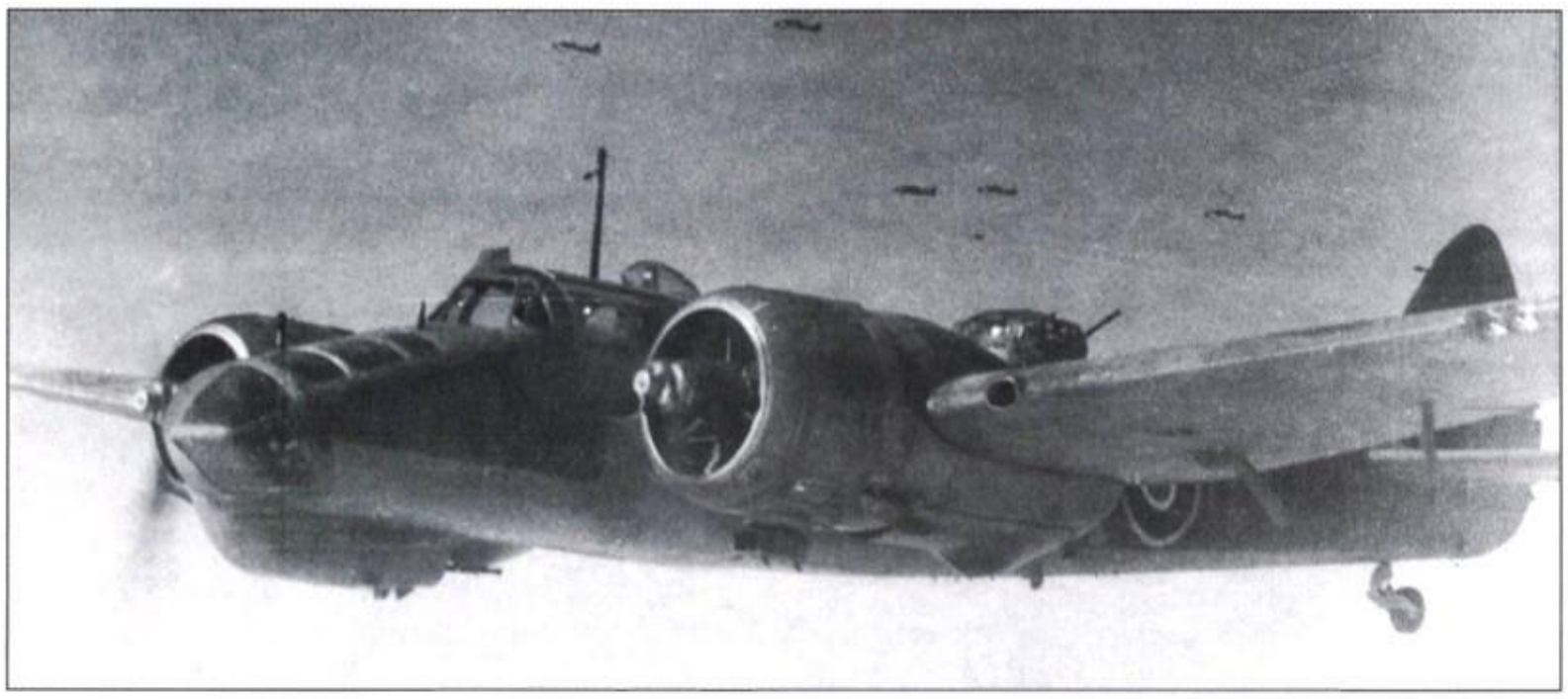
Nor was the Blenheim limited to the light bomber role, although this was the task for which it had been designed. The aircraft's plentiful availability (especially after the replacement of the Blenheim Mk I by the Blenheim Mk IV) and its performance characteristics allowed it to be pressed into service as a long-range escort fighter and night-fighter, and the aircraft pioneered the use of AI radar in the night-fighting role. It also proved popular and successful with RAF Coastal Command, and after withdrawal from the front line was used for a variety of training and support duties. To cap their achievements, Blenheim pilots won no fewer than three Victoria Crosses – one in Western Europe, one in the Far East during the Japanese onslaught against Malaya, and one in North Africa.

The Blenheim's combat record and large-scale production were perhaps surprising, since the Air Staff had never been particularly enthusiastic about its adoption. Ever since World War I, the RAF had felt that bombing operations should be conducted at long range, dropping heavy bombloads on strategic targets. Such operations followed from the traditions of Trencher's Great War Independent Force, and aimed to attack enemy cities, and 'root industries', aiming as much at achieving a 'moral' (psychological) effect as at causing physical destruction. Adherence to this doctrine became something of an article of faith for interwar staff officers, and almost any other facet of air power was seen as being of decidedly secondary importance. Spending and talent were concentrated within the bomber world, with other parts of the air force often being starved of resources. Thus, light bombers like the Blenheim were seen principally as a means of quickly building up a cadre of units and skilled aircrew for the planned new heavies, with additional (rather limited and decidedly unimportant) army co-operation and colonial policing roles. The widespread availability of the Blenheim led to the RAF fighting a rather different war to that envisaged by many of its inter-war strategists and tacticians. In service, the Blenheim pioneered the kind of daylight tactical bombing raids and anti-shipping strikes later carried out with such success by the Mosquito and Beaufighter.

The Blenheim was directly derived from the Bristol 135, a design study for a high-speed light transport, conveying six passengers at a cruising speed of 250 mph (402 km/h). This aircraft was first sketched by Frank Barnwell on 28 July

Of the mainstream roles undertaken by the Blenheim, perhaps the most underplayed was the work carried out by the Coastal Command units. This encompassed anti-invasion patrols, shipping escort (including 'Kipper' patrols over the North Sea fishing fleet), anti-shipping work and even attacks on Norwegian airfields. This six-ship of Mk IVFs is from No. 254 Squadron.

Blenheim Variants



Above: The Mk V was the final development of the Blenheim, and it was also the slowest and, although its defensive armament was good, it usually required a fighter escort. These aircraft are heading to attack a Japanese target in Burma.

Left: The standard Blenheim crew consisted of pilot, navigator and WOp/AG. Fighter variants usually dispensed with the navigator. This Indian-based aircraft was probably an ex-RAF machine with No. 3 Coast Defence Flight.

1933 as a conventional (but graceful and neat) low-winged monoplane, powered by a pair of new (then still unbuilt) 500-hp (373-kW) sleeve-valve Bristol Aquila I engines.

It was interest by Viscount 'Bubbles' Rothermere, millionaire proprietor of the *Daily Mail* group of newspapers, that transformed the Type 135 from paper study to flying hardware. The crusading Rothermere was aghast at the state of British civil aviation, and at the threatened domination of new-generation US airliners like the Douglas DC-1. Rothermere determined that he would have the fastest aircraft in Europe, and that it would be faster than the hated US rival.

The editor of the *Bristol Evening World* advised Rothermere about the Bristol 135, and found himself immediately ordered to find out all about the aircraft. In March 1934, Rothermere was told that a version of the aircraft powered by a pair of Mercury engines would be capable of at least 240 mph (386 km/h), and he decided to order one, principally as a high profile advert for British industry (and also for the far-sightedness and modern thinking of the *Daily Mail*!) but also to encourage business to use aircraft, and to point out the deficiencies of the RAF's biplane fighters. The Air Ministry (then the Bristol Aeroplane Company's best customer) did not object, and Bristol simultaneously began work on an eight-seat Mercury-engined light transport for Rothermere as the Type 142 and on a Private Venture Aquila-engined variant redesignated as the Type 143. Rothermere paid £18,500 for the aircraft, half up-front and half once the aircraft had flown.

Military interest

The Bristol 142 first flew on 12 April 1935, and demonstrated an extraordinary turn of speed. The Air Ministry immediately began making discreet inquiries into the possibility of a bomber conversion, and Barnwell unveiled the company's proposals for converting the 142 transport into the 142M bomber at a Design Conference on 9 July 1935. These proposals were looked upon with favour by the Air Ministry and a contract for 150 142Ms was placed in September 1935. The type was named Blenheim (commemorating Marlborough's famous victory) in 1936.

As a direct derivative of the Type 142, the Blenheim was of all-metal construction, albeit with fabric-covered, cable-operated, flying controls. The mid-set cantilever wing (raised by about 16 in/40 cm to allow an internal bomb bay to be provided) had mass-balanced Frise ailerons and trailing-edge split flaps, while the tailplane (with no dihedral) was similarly raised, but was increased in span. Unlike the 142's variable incidence tailplane, that of the 142M was fixed and provided with longer-chord, trim-tabbed elevators. The raised wing also raised the engine nacelles, which now almost entirely robbed the pilot of any view directly out to the sides. This peculiarity remained a feature of all subsequent Blenheim variants, though the later Beaufort and Beaufighter restored the pilot's view by slinging their engine nacelles below the wings. This was the price imposed by the Blenheim's unbroken internal bomb bay.

The Blenheim was built in large numbers (even by wartime standards) and after its withdrawal from front-line bomber operations in late 1942 in Europe and in mid-1943 in the Middle East the type soldiered on in a number of support roles until the end of the war. Once the war was over, the Blenheim disappeared with great rapidity, withdrawn from the last Flying Training Schools that used it during the summer of 1945. The type soldiered on a little longer in Turkey and Portugal, and especially in Finland, where the last Blenheim was withdrawn in 1958.

Stripped of armament and armour, the Blenheim Mk V in particular was quite a hot ship, with delightful handling characteristics (as long as both engines kept running). In the harsh environment of wartime combat, however, the Blenheim was found wanting, and many brave young men met untimely ends while proving its deficiencies. If you didn't have to risk your neck actually taking it into harm's way, there is little doubt that the Bristol Blenheim made a very fine gentleman's aerial conveyance – the very role for which its progenitor had originally been designed.

Jon Lake

Finnish Blenheims saw action in both the Winter and Continuation Wars against the Soviet Union, and then against German forces in the Lapland War. This Blenheim Mk I is seen in 1944, shortly after transfer to a bomber training unit.

Bristol 142M Blenheim Mk IF No. 25 Squadron Hawkinge, 1939

No. 25 Squadron exchanged its single-seat Gladiator biplanes for two-seat Blenheim Mk IFs in December 1938, and the last did not leave squadron service until early 1943, although they were largely supplanted by other types (Beaufighter, Havoc and Mosquito) from September 1940 onwards. Intended for long-range and night-fighter work, the Mk IFs were initially employed alongside a flight of AI radar-equipped Mk IVs in night-fighter trials, which on the outbreak of war led to the establishment of a North Sea patrol system to detect incoming aircraft. Long-range day fighter missions were undertaken from November 1939, including an attack on the seaplane base at Borkum and North Sea shipping escort missions. With the fall of France No. 25 Squadron provided fighter escort for the ships forming the evacuation fleet, and attempted to patrol over the receding beachhead. Radar trials continued in the meantime, and by the time of the Battle of Britain the squadron was ready to take on the enemy at night. However, the squadron's first night action, on 3/4 September 1940, led to the destruction of two Blenheims by 'friendly' Hurricanes. Later that month, Pilot Officer Herrick shot down a Do 17 and two He 111s in two nights, opening the squadron's account.

Camouflage and markings
This aircraft wears the standard RAF night-fighter scheme of the immediate pre-war period. Upper surfaces were in Dark Earth and Dark Green, while the undersides were in Night (port) and White (starboard). Most of the Mk IFs were initially painted all-black underneath, with the white added in late 1938. Type B roundels were worn for reduced conspicuity. No. 25 Squadron originally carried 'RX' squadron codes, as here, but these changed to 'ZK' in September 1939. The spearhead design on the fin, incorporating the squadron's badge of a hawk rising from a gauntlet, was removed on the outbreak of hostilities.

Mid-upper turret
Although there were plans to remove the weighty and draggy turret from Mk IFs and replace it with a Beaufighter-style cupola, the fighter Blenheim retained the bomber's Bl.Mk I turret with single gas-operated Lewis gun. The turret was semi-retractable.

Wing structure
The wing was built around a sturdy two-spar structure which carried through the fuselage. The main fuel tanks were located in the interspar gap on either side of the engine nacelles. The wing gun was positioned immediately outboard of the port outer tank.

Powerplant
Two Bristol Mercury VIIIs, rated at 825 hp (615 kW), powered the Blenheim Mk I. Evolved from the Jupiter, the Mercury was a nine-cylinder single-row radial which first ran in 1926. The Mercury VIII was one of a large family of derivatives, with single-stage supercharging and driving the propeller in a left-hand cycle at a geared reduction ratio of 0.572:1. Maximum power output at take-off, with 5 lb/sq in (34 kPa) in boost and 2,750 rpm, was 840 hp (627 kW). The engine ran on 87 octane fuel.

Crew access
The gunner accessed his station through a dorsal hatch immediately forward of the turret. Pilot and navigator climbed up over the wing and entered the cockpit through a sliding roof panel. A bail-out hatch was located below the cockpit

Gun armament
The Blenheim Mk I's standard forward-firing armament consisted of a single Browning 0.303-in machine-gun in the port wing. The Mk IF introduced a belly pack of four similar weapons, each with 500 rounds per gun. Although the pack provided a massive improvement over the single gun, the weight of fire was still inadequate against bomber targets, mainly due to the light punch of the rifle-calibre rounds. 20-mm cannon would have been far more effective. Guns were aimed by either a simple ring-and-bead sight, or by a GM 2 sight.

Blenheim Variants

Bristol 135

The Bristol 135 of 1933 was an unbuilt 'paper project', a light, high-speed six-seat civil transport, designed around new Aquila engines. The Bristol 135 remained on the drawing board, but formed the basis of the Bristol 142 ordered by Lord Rothermere – the aircraft that was effectively the first Blenheim.

Bristol 142

The Bristol 142 was a civil light transport, designed to accommodate a crew of two and six passengers, based on the unbuilt Bristol 135 but powered by a pair of proven (and more powerful) 650-hp (485-kW) Bristol Mercury VIS 2 radials rather than the new and immature Aquilas envisaged for the original Model 135. Carrying the B-Class civil registration R-12 (and not its allocated registration of G-ADCZ, which was never carried), the sole Model 142 (construction number 7838) made its maiden flight on 12 April 1935.

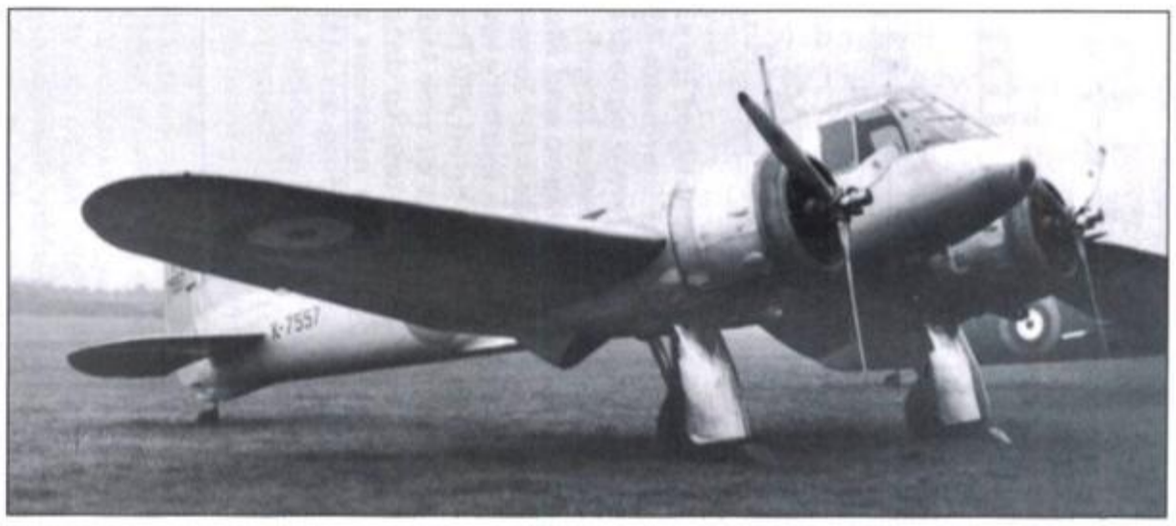
The Bristol 142 first flew with a solid nose (later gaining a tip-mounted landing/taxi lamp) and with four-bladed, fixed-pitch wooden propellers. An oval taxi lamp was added to the nose later, and the aircraft was fitted with three-bladed variable-pitch (but not constant-speed) airscrews. Soon afterwards, in June 1935, the aircraft (named *Britain First* by a delighted Rothermere) was sent to Martlesham Heath for further tests, proving to be faster than the new Gladiator prototype. The Air Ministry asked if it could retain the aircraft for full evaluation, seeing its potential as a light bomber. Rothermere agreed, going one better by presenting his aircraft to the nation. The aircraft was given the military serial K7557 in July 1935.

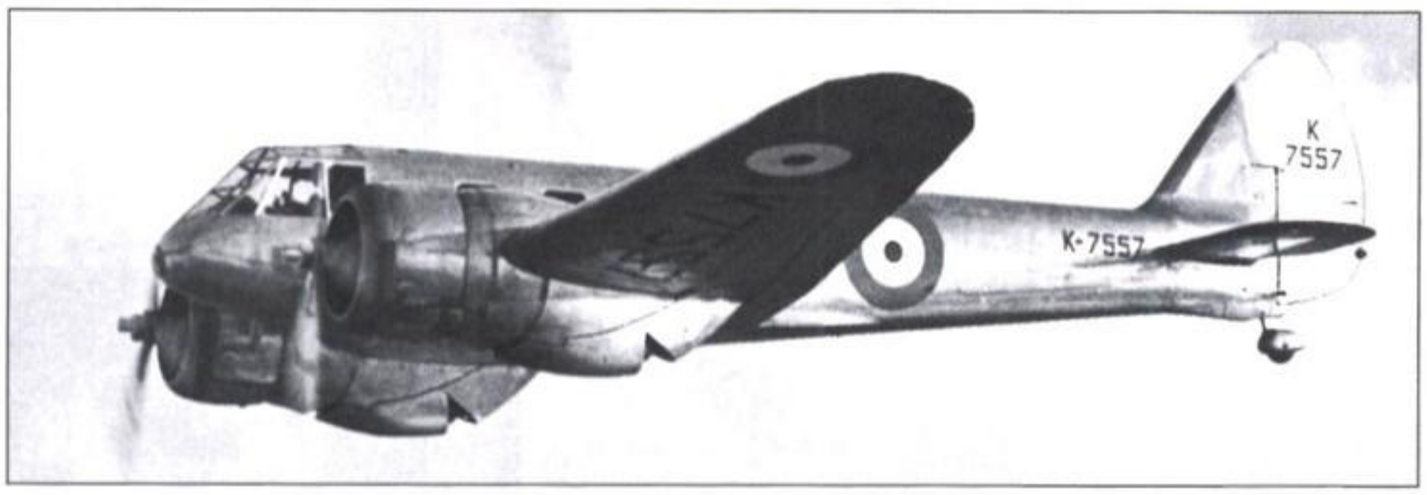
The Bristol 142 suffered minor damage when an engine cowling came loose in flight in July, and was returned to Filton for minor repairs. The aircraft returned to Martlesham with improved brakes, refined undercarriage doors and a neat spat over the tailwheel.

Having given away his first business aircraft, Lord Rothermere tried to order a replacement Bristol 142 on 14 February 1936, requesting an improved aircraft with a cruising speed of 360 mph (579 m/h). By the time he did so, Bristol had to turn him away, so busy was the company in preparing for production of the 142M for the RAF.

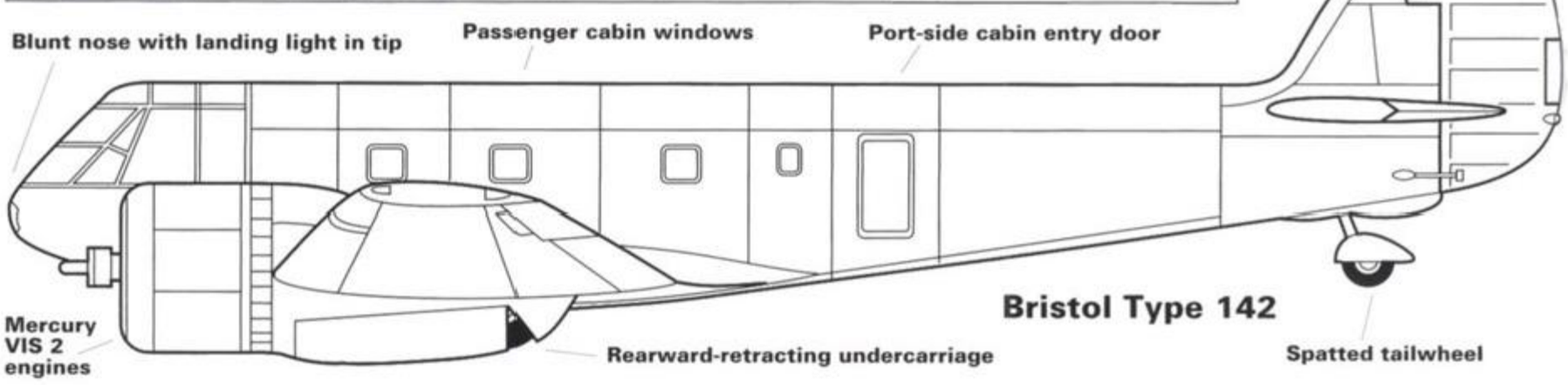
The 142 itself was passed to the RAE at Farnborough following the Martlesham trials, and continued flying until 1942. It then became a ground instructional airframe (as 2211M) with No. 10 SoTT at Kirkham, and was scrapped at Morris Motors, Cowley, Oxford, in 1944.

By the standards of 1935 the Type 142 was an advanced aircraft, exhibiting exceptionally clean lines. The undercarriage fairings looked clumsy with the wheels extended, but retracted into a neat nacelle installation. The aircraft originally flew with four-bladed fixed propellers before gaining these three-bladed variable props.





Left:* Britain First *is seen during trials at Martlesham Heath, during which it demonstrated a top speed greater than that of the Gladiator, which was then the 'state-of-the-art' fighter.



Bristol 142M Blenheim Mk I

The Bristol 142 ordered by Rothermere had demonstrated a staggering turn of speed, reaching 307 mph (494 km/h) during trials at Martlesham Heath. Air Ministry interest prompted Barnwell to prepare performance estimates for a Mercury-engined Bristol 142M and an Aquila-engined 143M. It was inevitable that a militarised derivative of either aircraft would be heavier, and that there would be a real risk of a bomber version having greater drag. This placed a premium on performance, leaving little chance that the Air Ministry would not opt for the marginally faster Mercury-engined 142M.

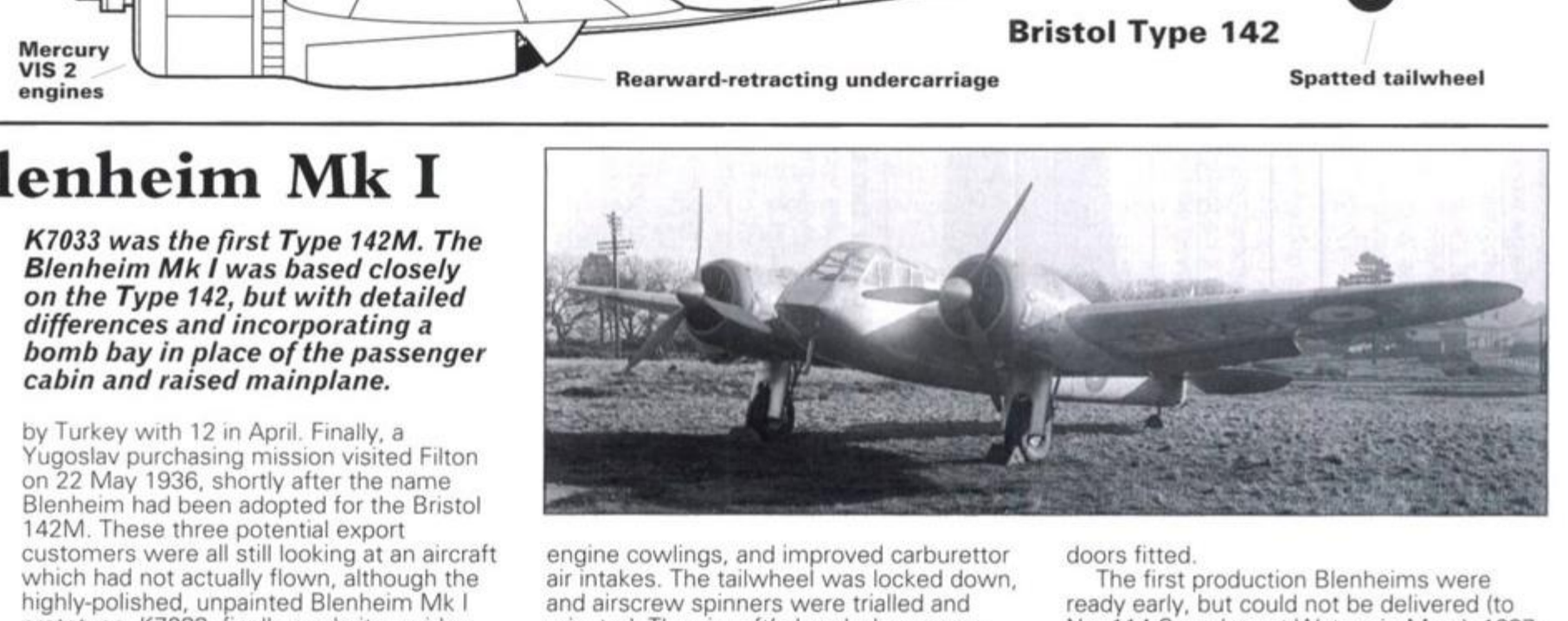
Instead of compensating with considerably more powerful engines for the increased structural weight (12,250 lb/ 5557 kg as opposed to the 142's 9,800 lb/ 4445 kg), higher-drag bomb-aimer's nose, powered dorsal gun turret, raised wing position, and heavy bombload – or undertaking a major drag reduction exercise – Bristol simply accepted that the military 142 would be slower than Rothermere's business transport, although the company did provide the Blenheim prototype with a fully-retractable tailwheel. Early estimates were that the 142M might be capable of a top speed of 278 mph (447 km/h), while the 143M offered a speed of 262 mph (421 km/h) with its Aquila engines. In the event, these predictions proved over-optimistic.

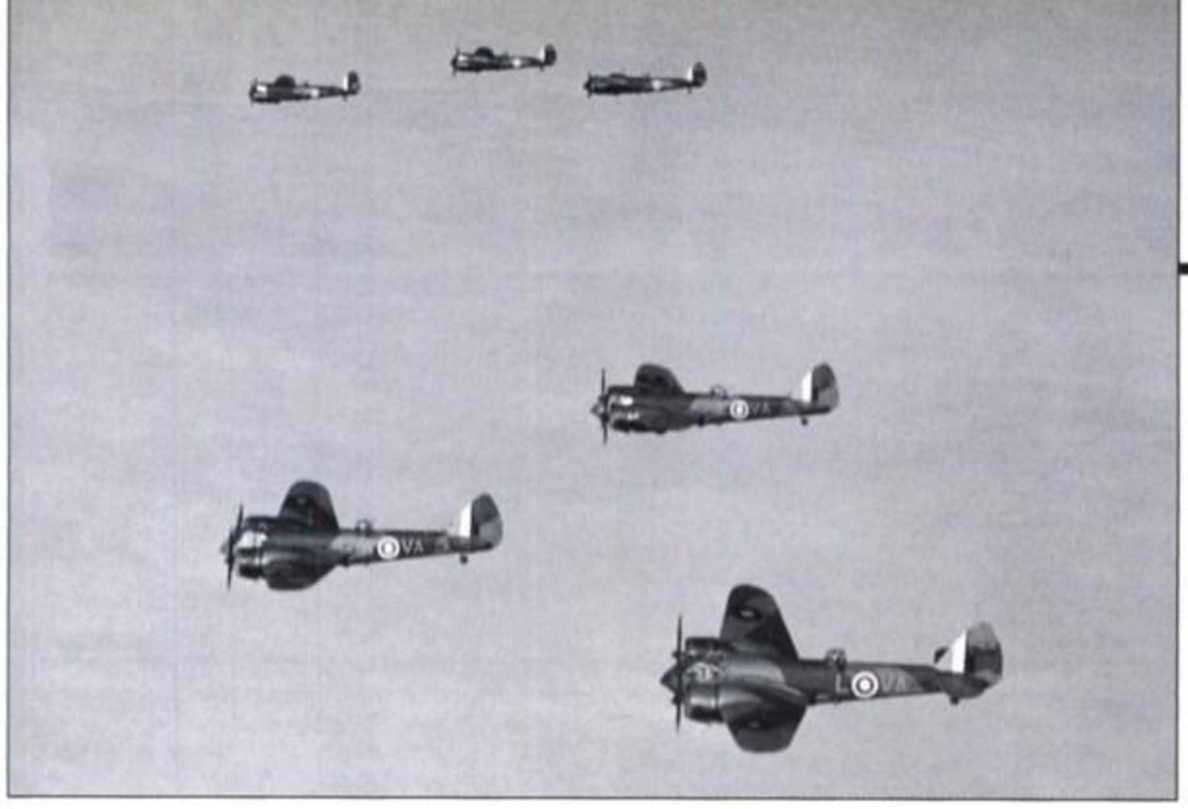
Following a July 1935 conference called by Air Commodore Verney, the Air Ministry issued Specification B.28/35, and ordered 150 Bristol 142Ms that September. Bristol also received requests for 10 aircraft from Finland, and for eight from Lithuania, which also wanted a manufacturing licence. Lithuanian interest evaporated, but Finland ordered 18 142Ms in March 1936, followed by Turkey with 12 in April. Finally, a Yugoslav purchasing mission visited Filton on 22 May 1936, shortly after the name Blenheim had been adopted for the Bristol 142M. These three potential export customers were all still looking at an aircraft which had not actually flown, although the highly-polished, unpainted Blenheim Mk I prototype, K7033, finally made its maiden flight on 25 June 1936. This aircraft was powered by a pair of Mercury VIII engines, each rated at 700 hp (522 kW), though these engines were later rated at 840 hp (626 kW).

Following trials at Martlesham Heath the prototype underwent some changes, gaining controllable cowl-flaps on the engine cowlings, and improved carburettor air intakes. The tailwheel was locked down, and airscrew spinners were trialled and rejected. The aircraft's bomb-doors were simple hinged flaps held closed by bungee cords. They were forced open by the weight of the bomb falling against them, and then snapped shut again. When the aircraft carried lighter bombs and incendiaries, the aircraft flew without bomb doors fitted.

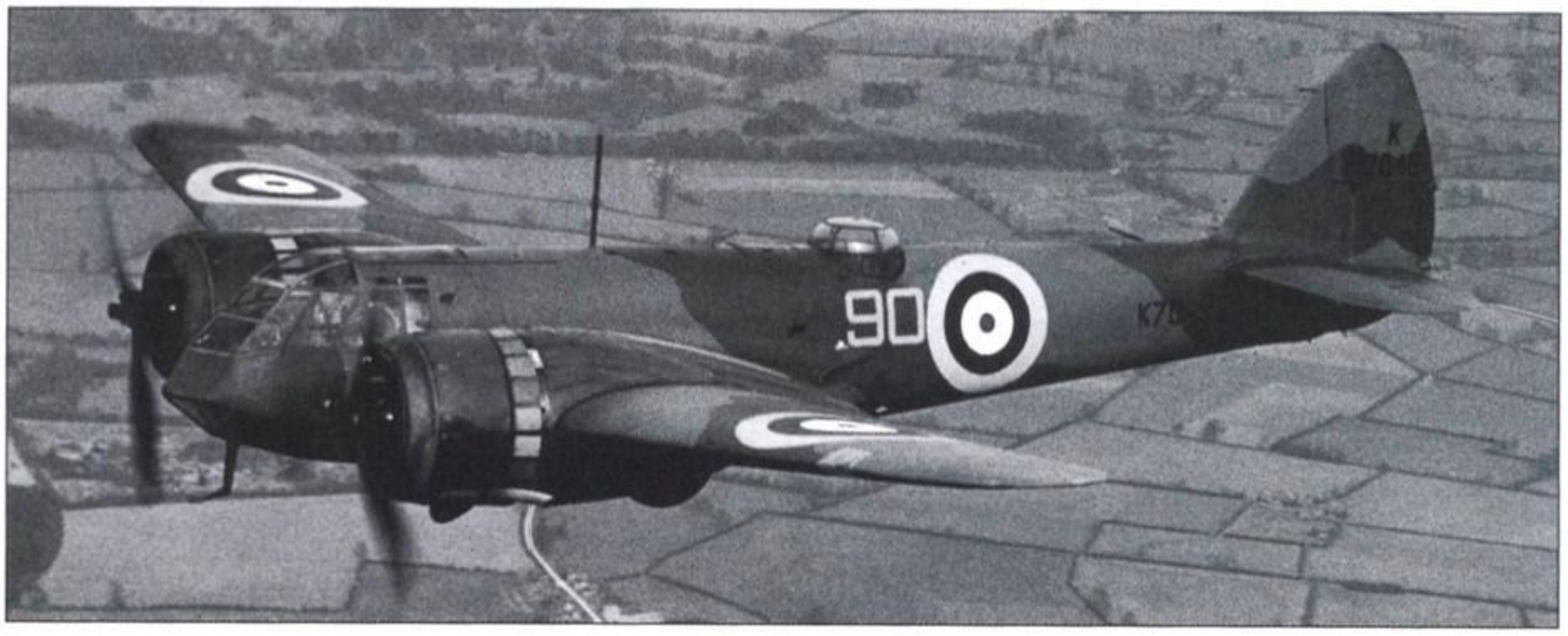
The first production Blenheims were ready early, but could not be delivered (to No. 114 Squadron at Wyton, in March 1937, until their type Bl.Mk I dorsal gun turrets were delivered to Filton for installation. The Blenheims rapidly equipped a number of home-based Bomber Command squadrons (some 17), and were also delivered to

K7033 was the first Type 142M. The Blenheim Mk I was based closely on the Type 142, but with detailed differences and incorporating a bomb bay in place of the passenger cabin and raised mainplane.


Bl.Mk I dorsal turret with single 0.303-in Lewis machine-gun
Bomb-aimer's station in glazed nose
Blenheim Mk I
Wing raised to mid position
Bomb bay underneath wing carry-through
Retractable tailwheel on early aircraft – fixed on later machines
Mercury VIII engines
Strengthened undercarriage with revised doors



Above: Blenheim Mk Is from No. 113 Squadron set out from their base at Heliopolis in Egypt to attack Italian airfields in Libya.



squadrons in Aden, Egypt, India, Iraq and the Far East. The home-based bomber squadrons were soon re-equipped with Blenheim Mk IVs (so that only four remained fully equipped by the outbreak of war) although the RAF still had 301 Blenheim Mk Is on charge, including 190 in the Near and Middle East, and 53 in India. Despite the brevity of its front-line career, the Blenheim Mk I was vitally important, forming the backbone of Bomber Command's pre-war expansion, and introducing a generation of airmen trained on single-engined biplane Harts and Hinds to the mysteries of enclosed cockpits, radio, twin-engine handling, retractable undercarriage, and adjustable, variable-pitch airscrews.

The Blenheim Mk I was a popular aircraft with its pilots – light and fully aerobatic, but could still 'bite' the unwary and the unlucky. Engine-out handling was especially difficult, and if an engine failed at low speed, disaster was inevitable, since relatively high speed was required for control with one engine out. The poor ergonomics of the cockpit also led to accidents, with inadvertent selection of fuel cocks and undercarriage leading to losses. When the Blenheim entered service, an RAF raised with rotary engines still regarded the engine-out, 'dead-stick' landing as the height of fashion, and 'rumbling' (adding a burst of power on approach to correct any error) was viewed as bad form, and likely to result in the culprit being fined a round of drinks in the mess. The practice of 'motoring' a Blenheim in to land was adopted slowly and reluctantly, but brought about a major improvement in the safety statistics.

Bristol itself built 700 Blenheim Mk Is, with construction numbers ranging between 7986 and 9239. These were 7986-8135 (K7033-K7182), 8137-8154 (modified to carry Swedish-supplied bombs for Finland as BL104-BL121), 8155-8166 (for Turkey as G-AFFP to G-AFFZ, reserialled as 2501-2512), 8380-8849 (L1097-L1530, L1531-L1546, L4817-L4834, and L4903-L4934), 8918-8949 (L4903-L4934), and 9222-9239 (for Turkey, as G-AFLA to G-AFLS, reserialled after delivery as 397-408 and 485-490). 8814 and 8815 were delivered to Yugoslavia as G-AFCE and G-AFCF to act as pattern aircraft for Yugoslav licence-production at Zemun.

A single Filton-built Blenheim Mk I, L1431, was sent to South Africa for evaluation during early 1939. Large orders were reportedly negotiated, but these were overtaken by events, and were never fulfilled. L1431 returned to Britain and was reserialled as AX683.

A.V. Roe at Chadderton built 250 Blenheim Is, serialled L6594-L6843. Of these, L6764-L6773 went to Finland, L6696-L6708 to Romania, and L6813, L6814 and L6817-L6834 to Yugoslavia as YU-BAA to YU-BAT. The 13 Romanian aircraft were delivered as an ill-judged and ultimately fruitless attempt to prevent that nation from joining the Axis, joining 39 Filton-built Blenheims delivered earlier. One year later Romania did join the Axis, and the aircraft ended up being used against Britain's Russian ally. Finland's March 1940 capitulation led to an armistice with Russia, but by the time a second Russo-Finnish war broke out, Russia was Britain's ally, and the Finnish Blenheims thus represented enemy aircraft. They fought effectively until the final armistice in September 1944. Some of the ex-RAF aircraft delivered to Yugoslavia were fitted with twin forward-firing 20-mm cannon, and served in the fighter role.

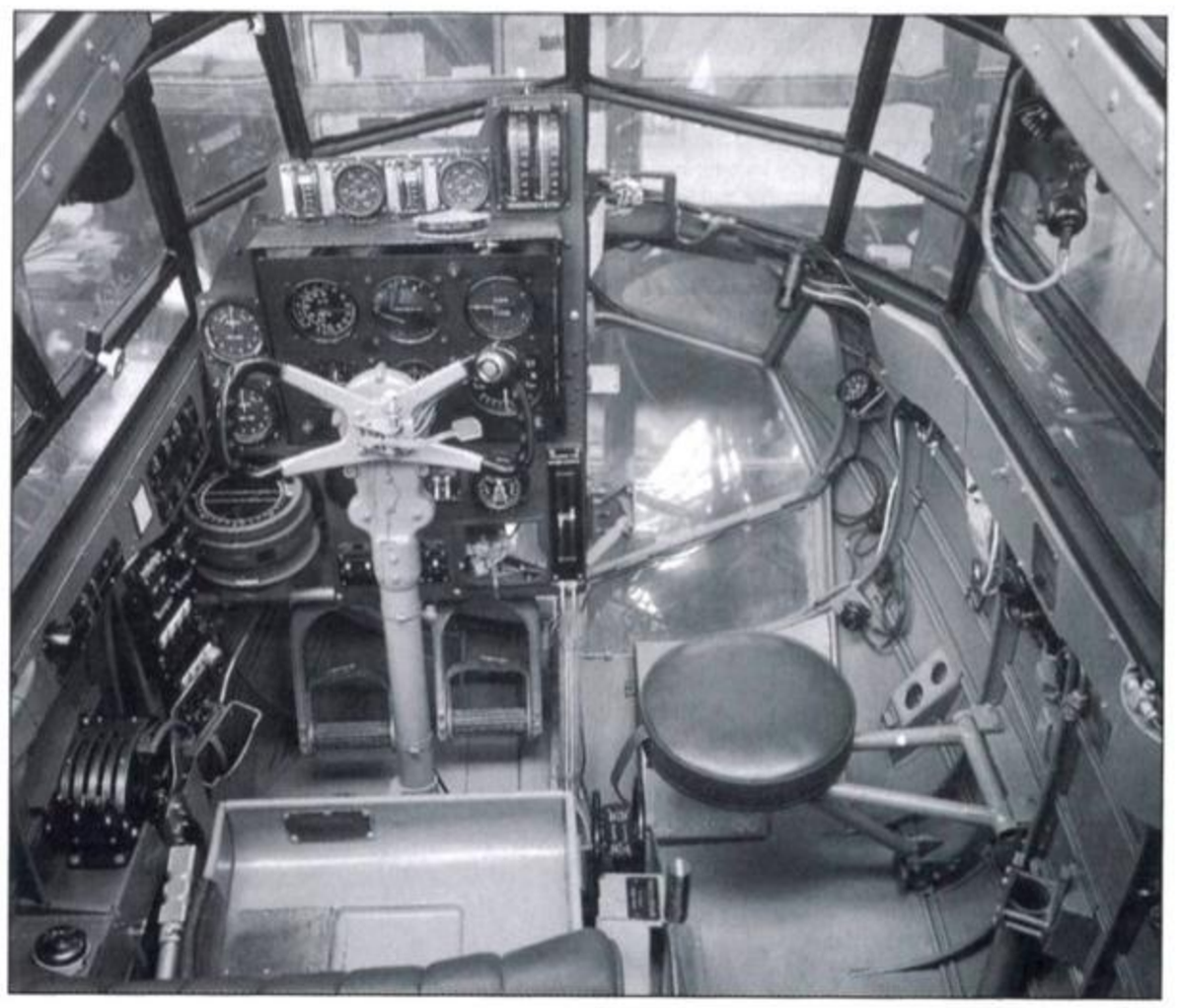
Rootes Securities at Speke built 380 Blenheim Mk Is. These were serialled L8362-L8407, L8433-L8482, L8500-L8549, L8597-L8632, L8652-L8701, L8714-L8761, L8776-L8800, L8827-L8876 and L9020-L9044.

Ikarus AD at Zemun in Yugoslavia built 16 Blenheim Mk Is, and 24 more aircraft under construction were destroyed before completion. Yugoslav patriots sabotaged the production line and incomplete aircraft to prevent them from falling into enemy hands, in the face of the German invasion in the spring of 1941.

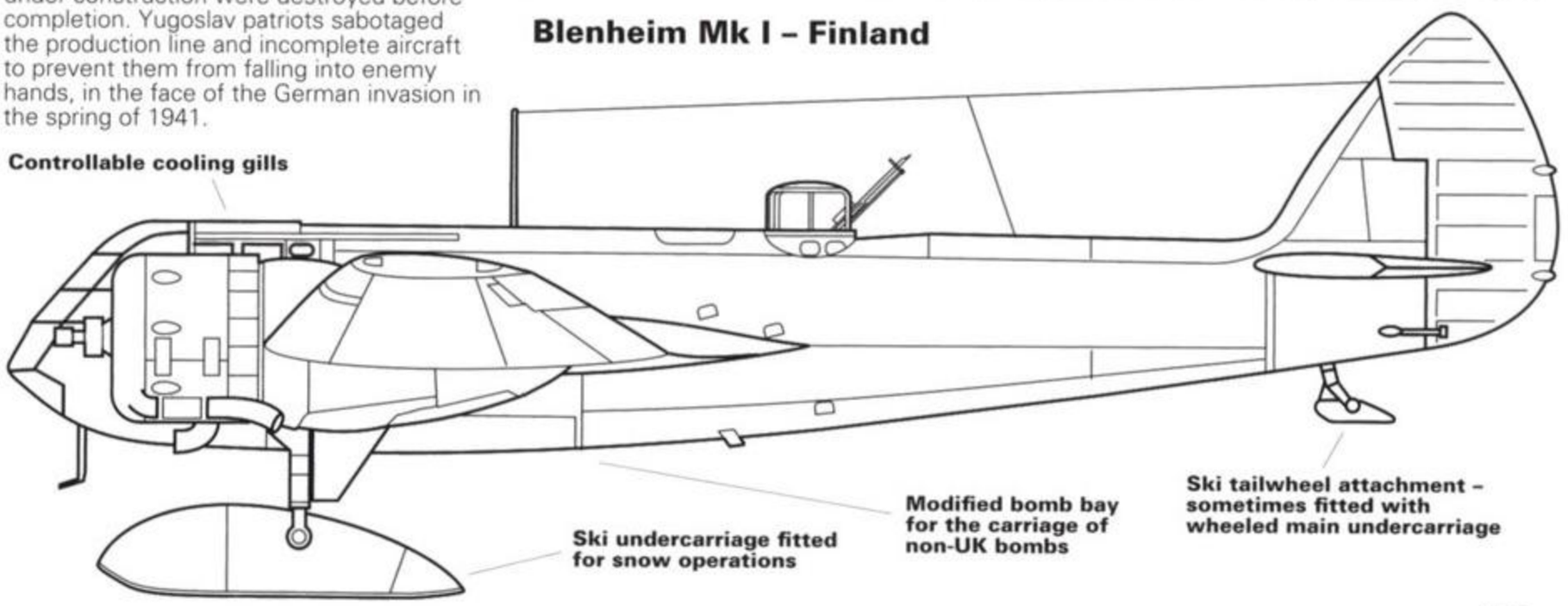
Above: No. 90 Squadron received Blenheim Mk Is in 1937, this example wearing typical pre-war markings with no fin flash, yellow roundel border and squadron number on the fuselage sides.

Top right: Between November 1940 and April 1941 No. 211 Squadron was embroiled in the campaign in Greece, attacking Italian positions along the Albanian front.

Right: The Mk I's cockpit gave the pilot a good view of the outside world, although the bomb-aimer/navigator operated in less than ideal conditions, without a decent chart table and with a cramped bomb-aiming position.



Blenheim Mk I – Finland

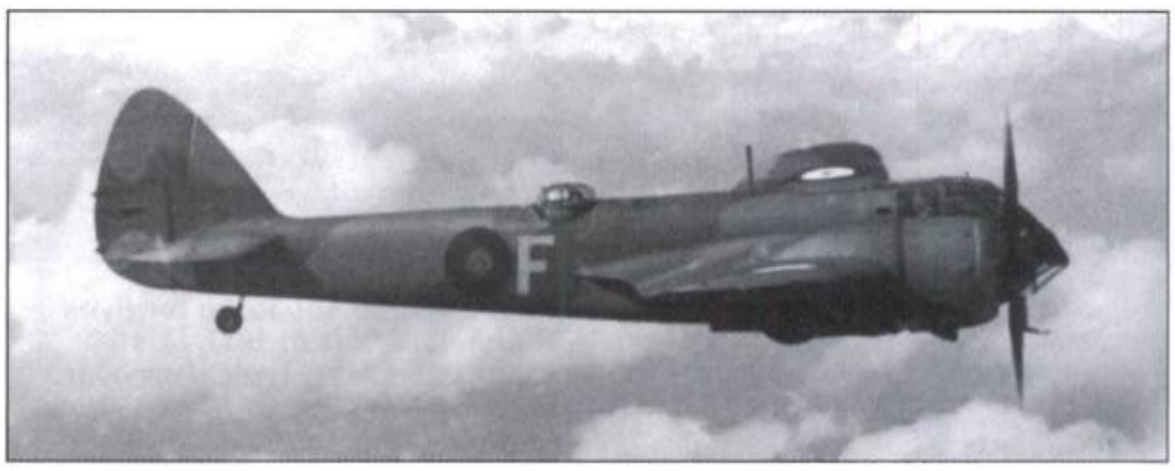

Controllable cooling gills
Ski undercarriage fitted for snow operations
Modified bomb bay for the carriage of non-UK bombs
Ski tailwheel attachment – sometimes fitted with wheeled main undercarriage

Bristol 142M Blenheim Mk IF

Right: This 54 OTU Mk IF is fitted with AI.Mk III radar, as denoted by the nose antenna.

Below: No. 25 Squadron operated its Mk IFs mostly around London. Visible are the hand/footholds for entry to the dorsal turret.

Right: Mk IFs equipped Fighter Command units and some Coastal Command squadrons. The latter provided fighter escorts for shipping.



Just as the Blenheim Mk I replaced Hawker Harts and Hinds in the light bomber role, so, too, it ended up replacing Hawker Demons in the two-seat fighter role. The replacement of the Blenheim Mk I by the Blenheim Mk IV within Bomber Command left large numbers of the early version redundant, and allowing Fighter Command to replace its remaining, obsolete, open-cockpit, biplane Demons with what was arguably a 'modern' monoplane fighter. In reality, the two-seat, heavy fighter was an anachronism, although the success of the Bristol Fighter in the Great War blinded some of the Air Staff (most of whom had commanded squadrons during that conflict) to this fact.

There was initially some debate as to what a Blenheim Mk IF should be like. Dowding favoured a stripped-down single-seater, with fixed, forward-firing armament only. Even if a second crew-member were to be carried, Dowding felt that he should have a low-drag, lightweight fixed cupola, with no gun, as on the Beaufighter. In the end, though, the solution chosen was less radical, with a standard Blenheim Mk I bomber (retaining its power-operated dorsal turret and fixed forward-firing Browning) fitted with a new ventral four-gun pack. The pilot was given ring-and-bead and GM2 gunsights. Four 0.303-in Browning machine-guns each had 500 rounds of ammunition. This was, of course, pitifully inadequate, and even the Spitfire and Hurricane (with eight such weapons) were too lightly armed. Against modern all-metal enemy aircraft, 20-mm cannon were needed. The Yugoslavs realised this and procured Blenheims armed with two forward-firing 20-mm cannon, but the Air Staff stuck with the rifle-calibre Browning and Vickers guns.

Proposals to replace the mid-upper turret with a cupola were finally rejected (by the then-ACAS, AVM Sholto-Douglas) in January 1939.

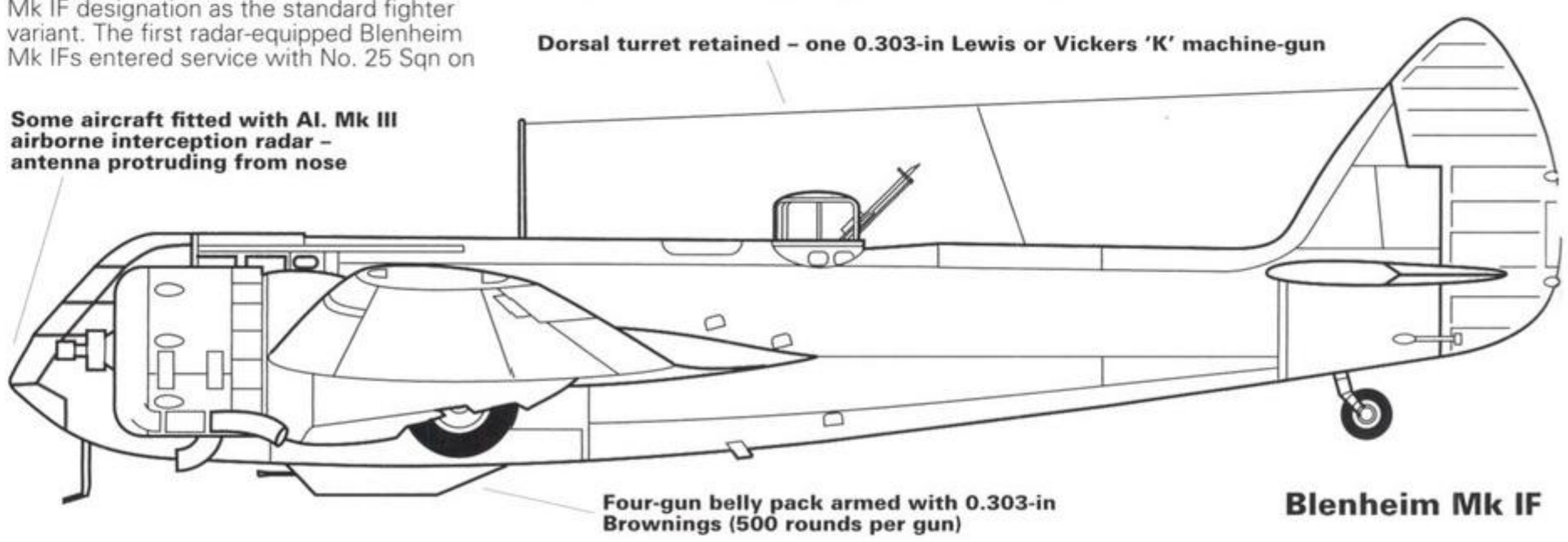
By the time it was available for Fighter Command use, no one believed that the Blenheim could compete with the latest monoplane fighters, but it was felt to be a potentially useful stop-gap pending the arrival of the Defiant, and a means of providing new squadrons formed during the expansion with something to fly, pending their re-equipment with Hurricanes or Spitfires.

This 'interim' training role was perhaps the Blenheim fighter's most important contribution, and it should be remembered that the majority of Blenheim fighter units actually never became operational with the type. Initially, however, the Blenheim Mk IF was used to re-equip Nos 23, 29, 64 and 25 Squadrons (in that order), each receiving 14 fully-converted Blenheim Mk IEs (later known as Blenheim Mk IFs) and five interim Mk IRs.

Unconverted Blenheim Mk Is began being allocated to Fighter Command from December 1938. Although a hastily modified prototype was undergoing testing at Martlesham Heath, the first trial conversion (L1512) was not started until 26 January 1939. The first 150 gun packs were hastily constructed by Southern Railways at Eastleigh, and were heavy and 'draggy' enough to knock the Blenheim Mk I's speed from 280 mph (450 km/h) to only 255 mph (410 km/h).

The Blenheim Mk IF was not originally perceived as a dedicated night-fighter, for internal reflections in the heavily glazed nose made night flying fraught with difficulties. The aircraft was fully equipped for night-flying, however, and when an aircraft was needed to train airborne radar operators, the Blenheim's capacious fuselage ensured that it was chosen for the task. When radar development promised to allow the deployment of an operational radar-equipped fighter, the Blenheim was again a natural choice, with its twin engines and two crew.

The radar-equipped night-fighter version of the aircraft retained the same Blenheim Mk IF designation as the standard fighter variant. The first radar-equipped Blenheim Mk IFs entered service with No. 25 Sqn on 31 July 1939, and 15 had been delivered by the outbreak of war. The radar-equipped Blenheims carried a single antenna projecting from their noses, with outward-pointing Yagi antennas under each outer wing. From late 1940, the night-fighters began to be replaced by Beaufighters. Some Blenheim Mk IFs were then stripped of their secret AI radar to go 'night intruding' over Luftwaffe bomber bases in France. About 200 Blenheim Mk IFs (with and without radar) were produced.


Dorsal turret retained – one 0.303-in Lewis or Vickers 'K' machine-gun
Some aircraft fitted with AI. Mk III airborne interception radar – antenna protruding from nose
Four-gun belly pack armed with 0.303-in Brownings (500 rounds per gun)

Blenheim Mk IF

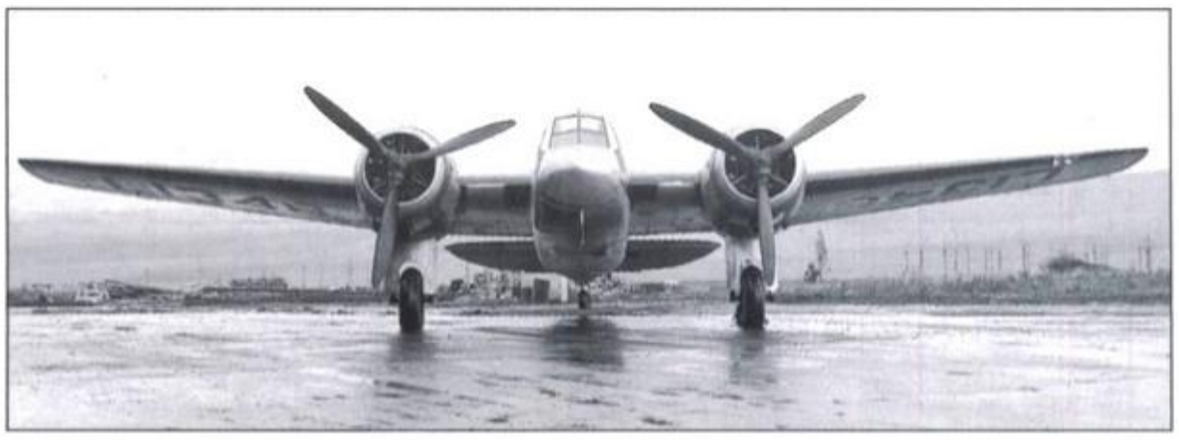
Bristol 142M Blenheim GR.Mk I

A single Blenheim Mk I (L6594) was fitted with a 37-mm Coventry Ordnance Works (COW) gun between the spars, firing vertically downwards for anti-submarine use. The installation was trialled at the A&AEE, Boscombe Down, but the programme went no further.

Bristol 142M Blenheim PR.Mk I

The Blenheim's performance should have made it a natural choice for reconnaissance operations early in the war, but in the event other types were pressed into service and only one dedicated reconnaissance Blenheim was produced. A single Mk I (L1348) was specially stripped and lightened, with no dorsal turret, and with bomb doors and panel lines taped over or filled. Special low-drag fairings were fitted to the nose and wingtips and the aircraft was painted in an extremely smooth colour scheme with largely sky-blue undersides. Rotol constant-speed airscrews improved performance, but the project was abandoned, and the aircraft (though assigned to the Photographic Development Unit at Heston), was used for testing various features devised for the Blenheim fighter, including various low-drag gun installations.

The PR.Mk I had a smoothly faired nos in place of the glazing. Cameras would have been mounted in the bomb bay.



Bristol 142M Blenheim Mk II

A single aircraft (L1222) was fitted with extra fuel tanks in the outer wings and with a strengthened landing gear to cope with higher (14,000 lb/6350 kg) take-off weights. This variant did not enter production in the UK, although its wing and undercarriage were adopted for the Bristol 149 Bolingbroke, and subsequently for the Blenheim Mk IV. L1222 flew with the new fuel tanks in September 1938. Although the Blenheim was able to land at the increased maximum all-up weight, its landing run was excessive, and fuel jettison valves, with underwing dump pipes, were fitted.

The 45 'short-nose' Blenheims built in Finland by Valtion Lentokonetehdas (State Aircraft Factory) were known by Bristol as Mk IIs, with revised outer wings, strengthened undercarriage and enlarged bomb bay. They also had a 0.303-in (7.7-mm) Browning machine-gun fitted in each wing. Manufacture did not begin until after the armistice of 13 March 1940, and the first Finnish Mk II flew on 14 June 1941. An initial batch (known as II series) of 15 (BL-146/160) was followed by a batch (known as V series) of 30 (BL-161/190) which was delivered during 1943.

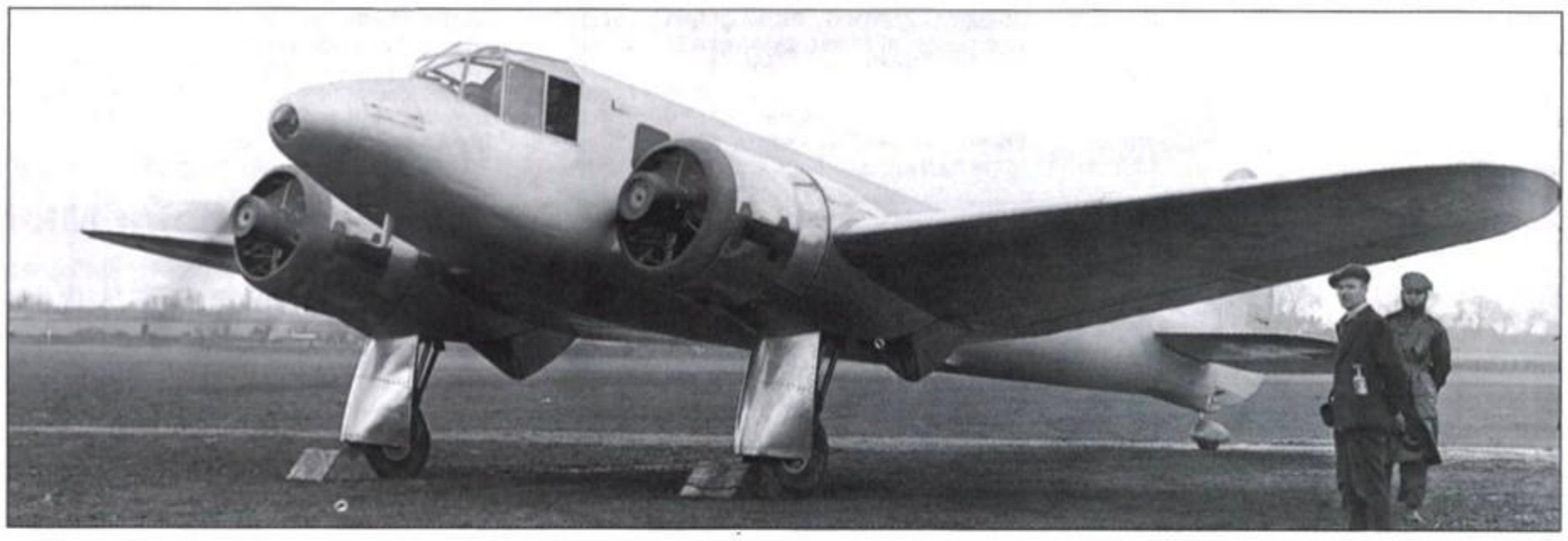
Blenheim Mk IIs are seen during Finnish operations. The Mk II incorporated several Mk IV features, including extra wing tanks and machine-guns in the wings.

Bristol 143

When Viscount Rothermere ordered his aircraft, Bristol decided to produce a second example for its own use, this one with two Aquila engines. Rather than simply building the Bristol 135, the company designed a new, Aquila-engined derivative of the 142. A longer, pointed nose was added and the fuselage was stretched (by 41 in/105 cm, from 39 ft 9 in/12.1 m to 43 ft 2 in/13.16 m) to accommodate eight passengers and two crew. Although completed before the 142 made its maiden flight, and despite being allocated the registration G-ADEK on 22 March 1935, the Model 143 (construction number 7839) was left without engines until late 1935, pending the completion of the Aquila flight test programme aboard the company's Bullpup and Bulldog testbeds. Finally, on 20 January 1936, the Bristol 143 took to the air, wearing the B-class identity R-14.

Even before it flew, the Bristol 143 was attracting interest among potential customers. The Ethyl Export Corporation proposed buying the prototype (once tests were complete) while Finland began negotiations for the supply of nine 'convertible' Bristol 143F versions with interchangeable nose and rear fuselage sections for the passenger, freight, postal and air ambulance roles, or for bomber and fighter-bomber duties. Some sub-variants featured a dorsal Lewis gun mounting, and some had a fixed, forward-firing 20-mm Madsen cannon.

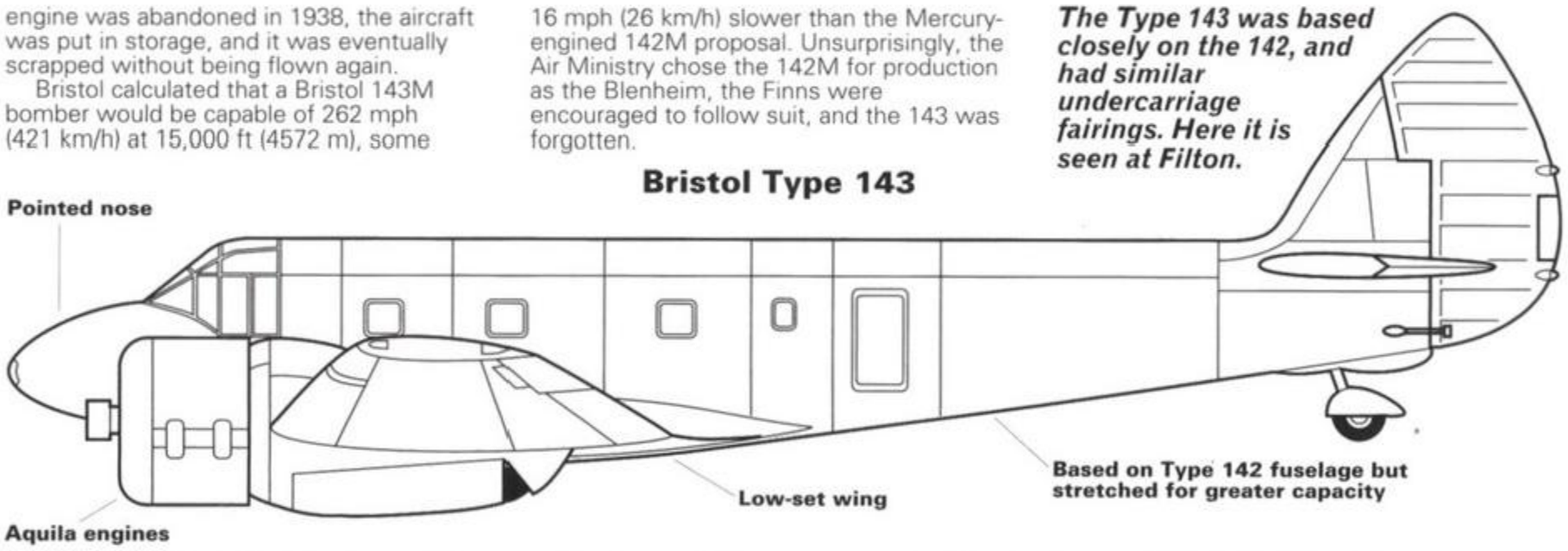
Originally fitted with two-bladed propellers, the Type 143 prototype was used by Bristol as an Aquila testbed. Despite an approach by Imperial Airways, the aircraft was not sold. When the Aquila engine was abandoned in 1938, the aircraft was put in storage, and it was eventually scrapped without being flown again.



Bristol calculated that a Bristol 143M bomber would be capable of 262 mph (421 km/h) at 15,000 ft (4572 m), some 16 mph (26 km/h) slower than the Mercury-engined 142M proposal. Unsurprisingly, the Air Ministry chose the 142M for production as the Blenheim, the Finns were encouraged to follow suit, and the 143 was forgotten.

The Type 143 was based closely on the 142, and had similar undercarriage fairings. Here it is seen at Filton.

Bristol Type 143



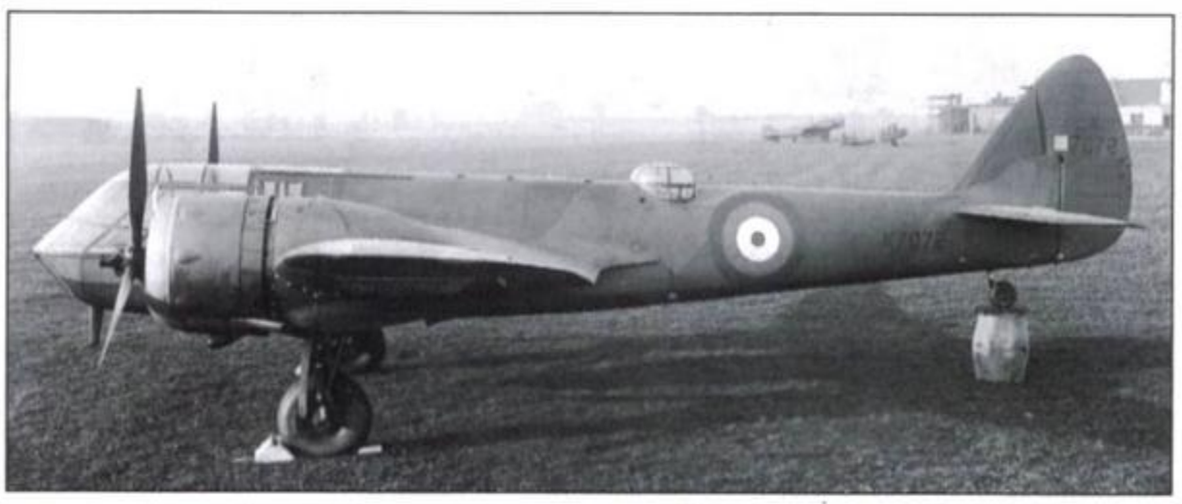
Bristol 149 Bolingbroke Mk I

The original Type 149 was a Blenheim-based general reconnaissance bomber intended as an interim Anson replacement for Coastal Command (to meet Specification G.24/35), pending the availability of the much improved Type 152 Beaufort torpedo bomber. The Type 149 was to have featured a wider fuselage, a new navigator's station, a separate radio operator's station, a new, roomier dorsal turret and supercharged Aquila engines. The engine choice promised to give increased range for the same basic fuel tankage, at the cost of a lower (254 mph; 409 km/h) top speed. The Type 149 was not accepted, and the specification was rewritten and combined with M.15/35 for a land-based torpedo bomber, resulting in the new specification M.10/36. The Bristol Type 152, which became the Beaufort, finally met this latter specification.

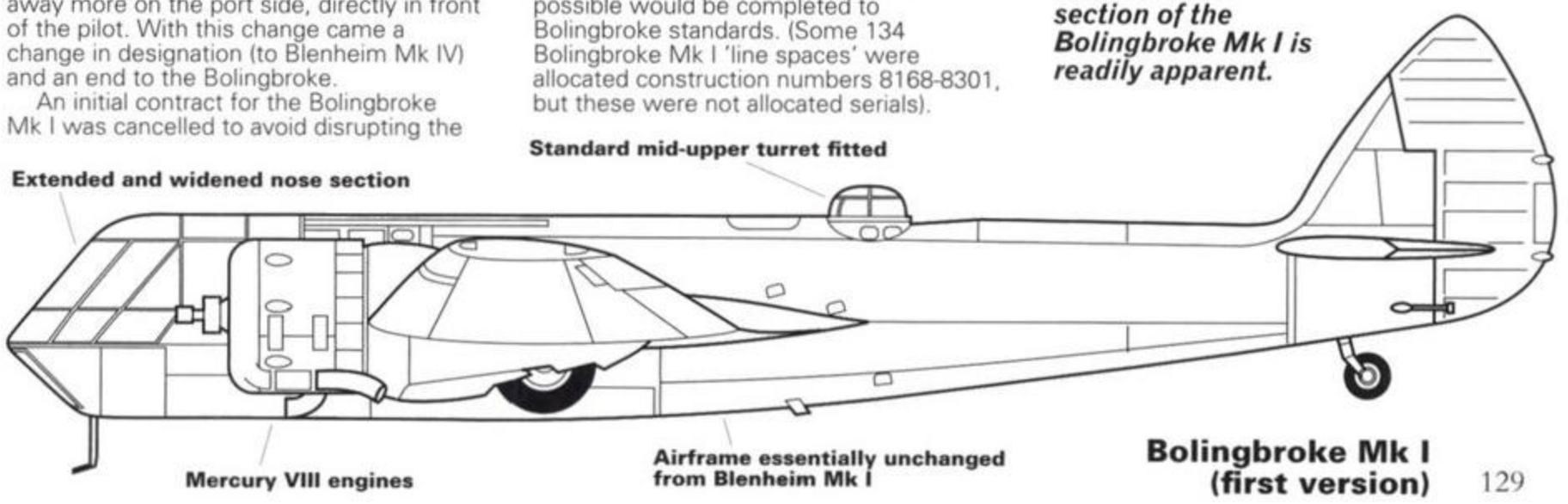
The Type 149 designation was transferred to a more modest interim general reconnaissance derivative of the Blenheim, with an extended nose and extra fuel, but retaining Mercury VIII engines, and with a standard Blenheim fuselage aft of the cockpit. An early Blenheim Mk I, K7072, was converted to serve as the prototype Bolingbroke, with the nose glazing retaining its original contours but being stretched 3 ft (0.9 m), far ahead of the pilot's seat, to allow the addition of a navigator/radio operator's station. The aircraft was fitted with underwing bomb racks, and fuel dump pipes were provided to keep landing weights within the required limits.

The prototype made its maiden flight in its new configuration on 24 September 1937, but test pilot Cyril Unwins felt that the windscreen was now too far ahead of the pilot's eyes (as on the contemporary Heinkel He 111) and the company decided to redesign the Bolingbroke's nose. The upper part of the new navigator/radio operator's station was cut away in front of a new windscreen, giving a more conventional stepped profile in side elevation. The nose glazing was scalloped away more on the port side, directly in front of the pilot. With this change came a change in designation (to Blenheim Mk IV) and an end to the Bolingbroke.

An initial contract for the Bolingbroke Mk I was cancelled to avoid disrupting the Blenheim production line, on condition that as many Blenheims already on order as possible would be completed to Bolingbroke standards. (Some 134 Bolingbroke Mk I 'line spaces' were allocated construction numbers 8168-8301, but these were not allocated serials).



From the side the extended nose section of the Bolingbroke Mk I is readily apparent.


Standard mid-upper turret fitted
Extended and widened nose section
Mercury VIII engines
Airframe essentially unchanged from Blenheim Mk I

Bolingbroke Mk I (first version)

Bristol 149 Blenheim Mk III

The Blenheim Mk III designation was reserved for an unbuilt short-range Blenheim variant which was to have featured the new Blenheim Mk IV long nose, without the new variant's extra fuel tankage. Some Blenheim Mk IIIs were built, but they were fitted with the new tanks before delivery, and thus became Blenheim Mk IVs. These aircraft have been referred to in some documents as Blenheim Mk IVs, with the designation Mk IVL applying to aircraft with the increased fuel tankage.

This is one of the aircraft occasionally referred to as a Mk IVL. In fact, it is no different to a standard Mk IV.

Bristol 149 Blenheim Mk IV

The stepped and scalloped long nose first flown on K7072 in December 1937, replacing the original Bolingbroke 'lengthened snub nose', was the major recognition feature of the Blenheim Mk IV. This at last gave the navigator a proper chart table, and a more roomy and pleasant working environment. In the Mk I he had to sit on the cramped jump seat beside the pilot, his map on his knees. The new version also introduced the Mercury XV engine, with 9 lb/sq in (62 kPa) boost for 3 minutes 'combat boost' when using 100 octane fuel, and providing a reserve of 30 mph (48 km/h) in emergency.

The Blenheim Mk IV had originated in a specification for a long-range version for Coastal Command. Although the variant was destined to see extensive service with that Command, most of the first Blenheim Mk IVs were simply used as longer-range, more capable replacements for Bomber Command Blenheim Mk Is, allowing these to be cascaded to Fighter Command and to overseas Commands.

The first Blenheim MK IVs delivered to the RAF actually went to No. 53 Squadron, an Army Co-operation Command unit tasked with strategic reconnaissance operations. By the outbreak of war the RAF had 168 Blenheim Mk IVs on charge, equipping two Army Co-operation Command squadrons, and seven front-line Bomber Command units. The Blenheim Mk I, by comparison, equipped only four front-line Bomber Command squadrons on that day, and another unit was in the process of conversion.

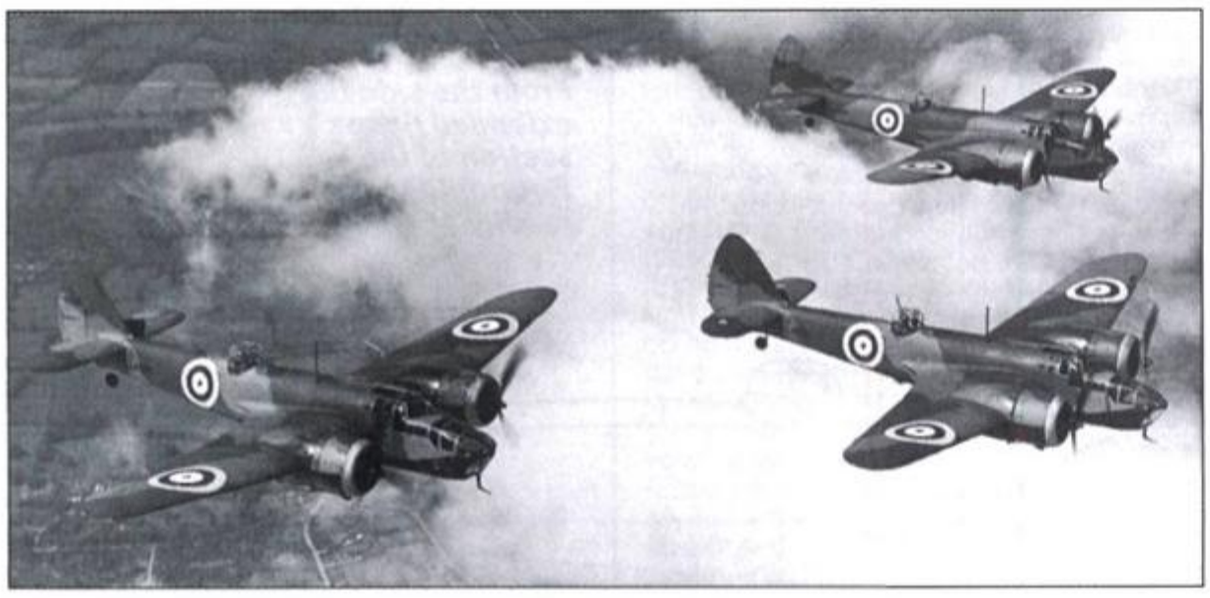
The Blenheim I was not greatly improved in service, for the RAF's response to the intensifying threat was to relegate the variant to service overseas or in other roles. The Blenheim Mk IV, on the other hand, was subject to a large number of improvements in service, especially after the outbreak of war. Working parties from Filton were rapidly dispatched to front-line airfields where aircraft received additional armour plate, self-sealing fuel tanks, reflector gunsights, IFF and extra radios.

Even more importantly, the Blenheim Mk IVs received improved firepower. The original Bl.Mk I and Mk II turrets fitted pre-war, carrying a single Lewis gun, had

K7072, the Bolingbroke Mk I prototype, is seen with the scalloped nose which made it, effectively, the prototype Blenheim Mk IV.

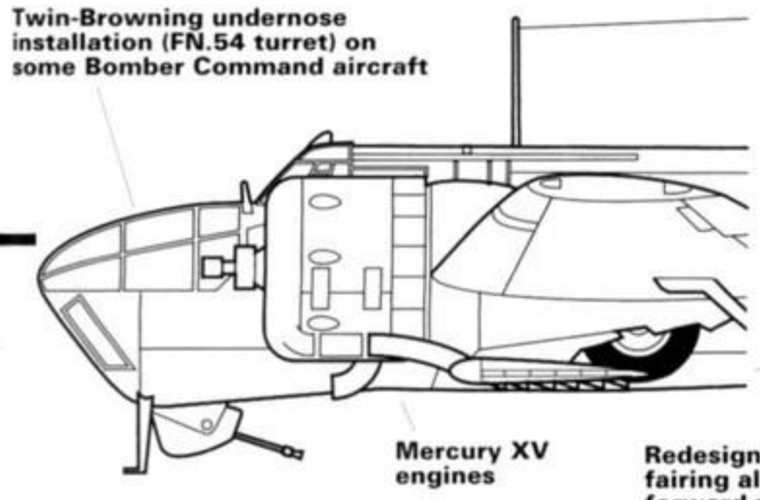
Above: The Mk IV's extended nose provided a much better station for the bomb-aimer/navigator, while the scalloping provided the pilot with good forward visibility. The aircraft is from No. 139 Squadron.

Below: The single turret-mounted Lewis or Vickers gun, as carried by these Mk IVs pre-war, provided insufficient defence and was replaced by a twin-gun installation, either of two Vickers or two Brownings.



Bristol Blenheim Mk IV cutaway

1 Starboard navigation light
2 Starboard formation light
3 Wing rib construction
4 Aileron control rod
5 Starboard aileron
6 Aileron tab
7 Starboard outer flap
8 Outboard, long-range fuel tank, capacity 94 Imp gal (427 litres)
9 Fuel tank filler cap
10 Starboard nacelle fairing
11 Main inboard fuel tank, capacity 140 Imp gal (636 litres)
12 Oil tank, capacity 11.5 Imp gal (52 litres)
13 Engine bearers
14 Oil cooler exhaust duct
15 Engine cooling flaps
16 Cowling blister fairings
17 Bristol Mercury XV nine-cylinder radial engine
18 Oil cooler ram air intakes
19 Propeller hub mechanism
20 De Havilland three-bladed propeller
21 Nose compartment glazing
22 Cabin air intake
23 Navigator/bombardier's instrument panel
24 Bomb-aiming windows
25 Pitot tube
26 Rearward-firing, ventral machine-gun cupola
27 Browning 0.303-in (7.7-mm) machine-gun
28 Fireman's axe

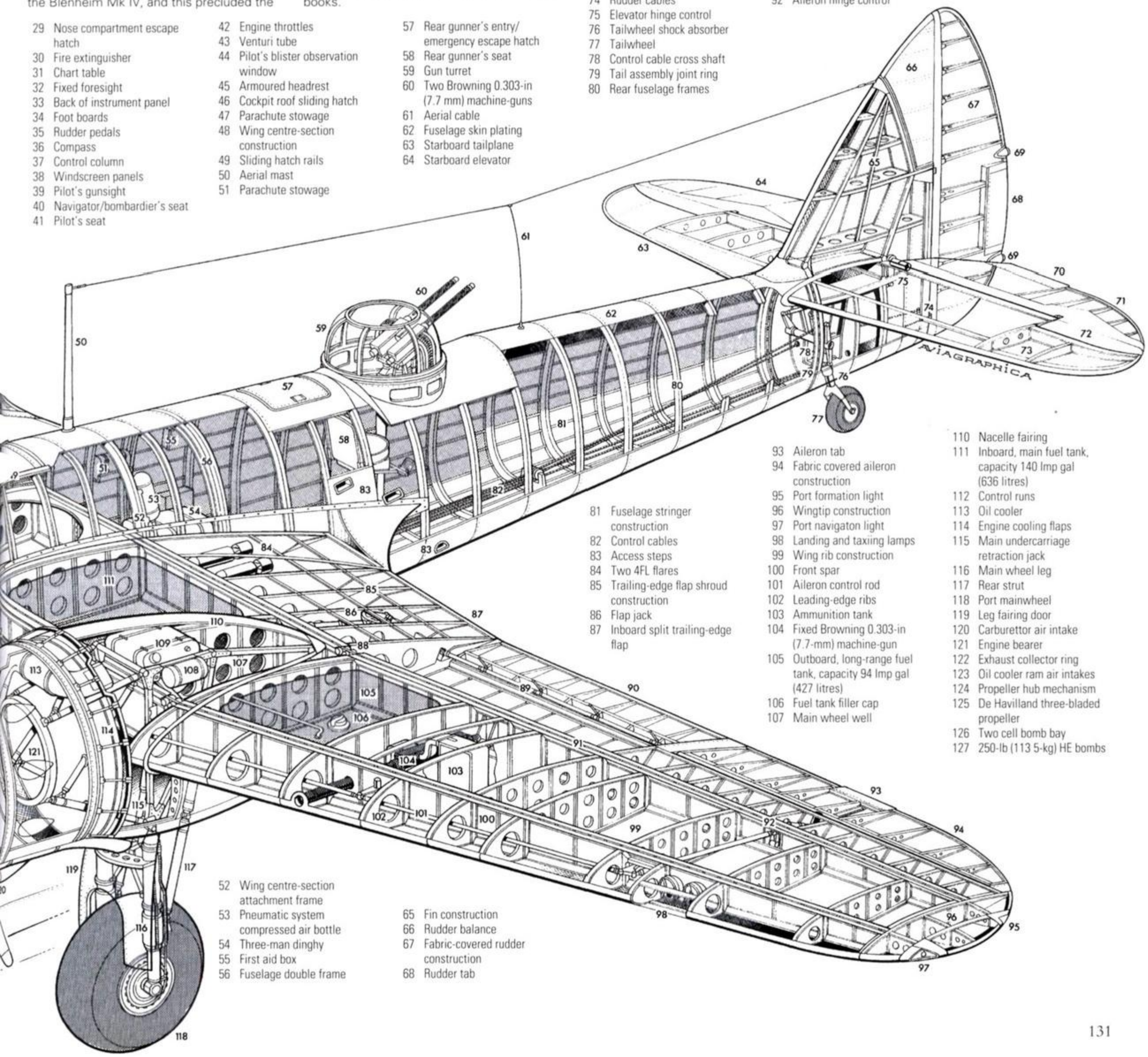


already been superseded by the Mk III turret with a single Vickers K gun. The drum-fed Vickers had a maximum useful range of about 400 yd (365 m), after which bullet drop made aiming a matter of luck and velocity was too low to inflict meaningful damage. The war brought modification of these turrets to Mk IIIA standards with two Vickers guns, or to Mk IV standards with a pair of belt-fed Brownings. Even with the Brownings, range of the defensive armament was inadequate, especially when up against a Bf 109, whose 20-mm cannon had an effective range in excess of 1,000 yd (915 m). These various 'improvements' increased the Blenheim Mk IV's maximum all-up weight to 14,500 lb (6577 kg) in January 1940. Further increases in weight followed, but 16,000 lb (7257 kg) was regarded as an absolute structural limit for the Blenheim Mk IV, and this precluded the fitting of heavier armour. The Blenheim Mk IV was about 12 mph (19 km/h) slower than the Mk I, and a full 40 mph (64 km/h) slower than Rothermere's *Britain First*. Fighter performance, meanwhile, had improved by leaps and bounds, making the Blenheim's once-proud boasts something for the history books.

Blenheim Mk IV

Continuous turret development – Bl.Mk I or II (single Lewis), Bl.Mk III (single Vickers 'K'), Bl.Mk IIIA (two Vickers 'K') or Bl.Mk IV (two Browning)
Flame-dampers fitted to exhaust for night ops
Redesigned nose with scalloped fairing allowing pilot good forward visibility
Fuel jettison pipes under wing
Based on Mk I airframe
Single rear-firing gun in undernose glazed blister

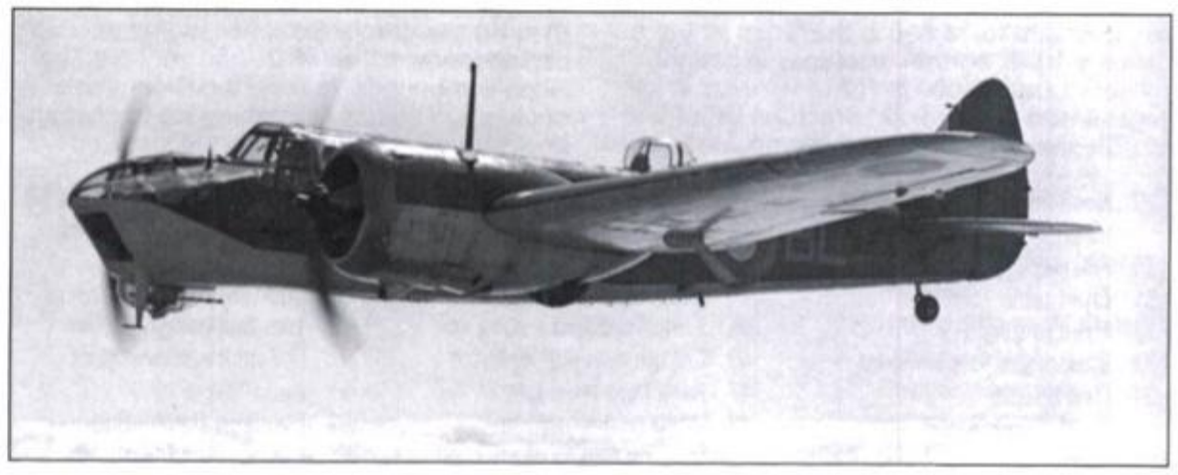
29 Nose compartment escape hatch
30 Fire extinguisher
31 Chart table
32 Fixed foresight
33 Back of instrument panel
34 Foot boards
35 Rudder pedals
36 Compass
37 Control column
38 Windscreen panels
39 Pilot's gunsight
40 Navigator/bombardier's seat
41 Pilot's seat
42 Engine throttles
43 Venturi tube
44 Pilot's blister observation window
45 Armoured headrest
46 Cockpit roof sliding hatch
47 Parachute stowage
48 Wing centre-section construction
49 Sliding hatch rails
50 Aerial mast
51 Parachute stowage
57 Rear gunner's entry/ emergency escape hatch
58 Rear gunner's seat
59 Gun turret
60 Two Browning 0.303-in (7.7 mm) machine-guns
61 Aerial cable
62 Fuselage skin plating
63 Starboard tailplane
64 Starboard elevator
69 Tail navigation lights
70 Elevator tab
71 Fabric-covered elevator construction
72 Elevator balance
73 Port tailplane
74 Rudder cables
75 Elevator hinge control
76 Tailwheel shock absorber
77 Tailwheel
78 Control cable cross shaft
79 Tail assembly joint ring
80 Rear fuselage frames
88 Outer wing spar attachment joint
89 Flap lever mechanism
90 Outboard split trailing edge flap
91 Rear spar
92 Aileron hinge control
108 Auxiliary oil tank, capacity 2.5 Imp gal (11 litres)
109 Main oil tank, capacity 11.5 Imp gal (52 litres)



52 Wing centre-section attachment frame
53 Pneumatic system compressed air bottle
54 Three-man dinghy
55 First aid box
56 Fuselage double frame
65 Fin construction
66 Rudder balance
67 Fabric-covered rudder construction
68 Rudder tab
81 Fuselage stringer construction
82 Control cables
83 Access steps
84 Two 4FL flares
85 Trailing-edge flap shroud construction
86 Flap jack
87 Inboard split trailing-edge flap
93 Aileron tab
94 Fabric covered aileron construction
95 Port formation light
96 Wingtip construction
97 Port navigaton light
98 Landing and taxiing lamps
99 Wing rib construction
100 Front spar
101 Aileron control rod
102 Leading-edge ribs
103 Ammunition tank
104 Fixed Browning 0.303-in (7.7-mm) machine-gun
105 Outboard, long-range fuel tank, capacity 94 Imp gal (427 litres)
106 Fuel tank filler cap
107 Main wheel well
110 Nacelle fairing
111 Inboard, main fuel tank, capacity 140 Imp gal (636 litres)
112 Control runs
113 Oil cooler
114 Engine cooling flaps
115 Main undercarriage retraction jack
116 Main wheel leg
117 Rear strut
118 Port mainwheel
119 Leg fairing door
120 Carburettor air intake
121 Engine bearer
122 Exhaust collector ring
123 Oil cooler ram air intakes
124 Propeller hub mechanism
125 De Havilland three-bladed propeller
126 Two cell bomb bay
127 250-lb (113 5-kg) HE bombs

Above: Mk IVs from No. 139 Squadron are seen during a mission over France in 1940.

Below: This No. 40 Squadron Mk IV exhibits the initial standard of rear-facing undernose gun.



Although somewhat underpowered, the Blenheim was considered a pleasant aircraft to fly.

The Blenheim Mk IV was hopelessly vulnerable to enemy fighters, and large unescorted formations merely gave the enemy more targets at which to shoot. Some units (notably No. 82 Squadron) began sending out 12 Blenheims singly rather than in formation, and when they followed different routes, 'hedge-hopping' to the target, they proved more survivable and inflicted greater punishment on the enemy.

Many Blenheims were fitted with a single gimbal-mounted 0.303-in Vickers 'K' gun in the nose. This originated with one unit, but eventually became an official modification applied across the fleet. In the Middle East and North Africa some aircraft had a fixed 20-mm cannon fitted, firing through a hole in the nose glazing. For covering the vulnerable area below and behind the aircraft, some AASF squadrons jury-rigged machine-guns under the tail and/or in the rear part of the engine nacelles. Later, a single rearward-firing machine-gun was mounted in a transparent blister below the emergency exit hatch, and eventually some aircraft even received an articulated undernose turret housing a pair of Brownings in an FN.54 mounting.

Bristol built 312 Blenheim Mk IVs with construction numbers ranging from 8850 to 9873. These were 8850-8917 (L4835-L4902), 9240-9471 (N6140-N6174, N6176-N6220, N6223-N6242, P4825-P4864, P4898-P4927, P6885-P6934, P6950-P6961), and 9862-9873 (replacements for 12 Greek aircraft, the latter having been delivered as G-AFXD to G-AFXO). Of these Filton-built Blenheim Mk IVs, nine aircraft had been earmarked for the Royal Canadian Air Force and were to have been fitted with D/F radio like the Bolingbroke Mk IV, although only four (P4856-P4859) were actually completed to this standard, the rest being finished as standard Blenheim Mk IVs for the RAF.

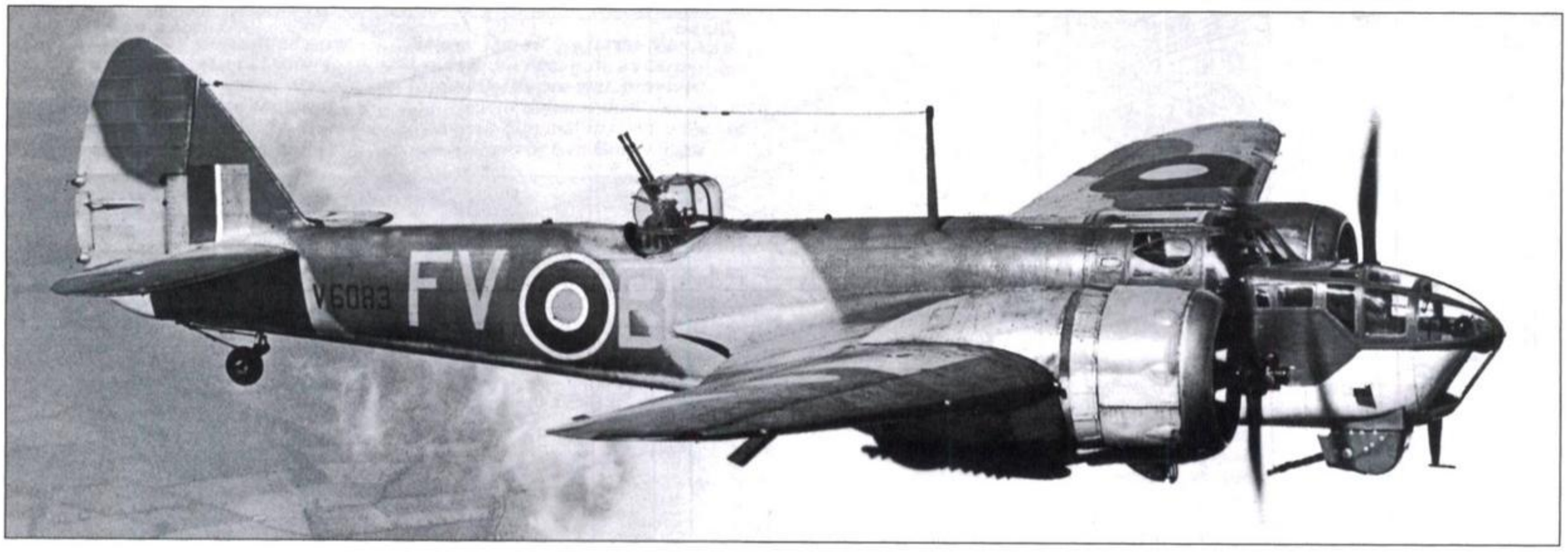
When Blenheim Mk IV production ended at Filton, the production jigs were transferred to the various shadow factories, allowing an increase in output.

AV Roe at Chadderton built 750 Blenheim Mk IVs: N3522-N3545, N3551-N3575, N3578-N3604, N3608-N3631, R2770-R2799, Z5721-Z5770, Z5794-Z5818, Z5860-Z5909, Z5947-Z5991, Z6021-Z6050, Z6070-Z6104, Z6144-Z6193, Z6239-Z6283, Z6333-Z6382, Z6416-Z6455, Z9533-Z9552, Z9572-Z9621, Z9647-Z9687, Z9706-Z9755 and Z9792-Z9836.

Rootes Securities at Speke and Blythe Bridge built 2,100 Blenheim Mk IVs: L9170-L9218, L9237-L9273, L9294-L9342, L9375-L9422, L9446-L9482, R3590-R3639, R3660-R3709, R3730-R3779, R3800-R3849, R3870-R3919, T1793-T1832, T1848-T1897, T1921-T1960, T1985-T2004, T2031-T2080, T2112-T2141, T2161-T2190, T2216-T2255, T2273-T2292, T2318-T2357, T2381-T2400, T2425-T2444, V5370-5399, V5420-V5469, V5490-V5539, V5560-V5599, V5620-V5659, V5680-V5699, V5720-V5769, V5790-V5829, V5850-V5899, VV5920-V5969, V5990-V6039, V6060-V6099, V6120-V6149, V6170-V6199, V6220-V6269, V6290-V6339, V6360-V6399, V6420-V6469, V6490-V6529, Z7271-Z7320, Z7340-Z7374, Z7406-Z7455, Z7483-Z7522, Z7577-Z7596, Z7610-Z7654, Z7678-Z7712, Z7754-Z7803, Z7841-Z7860, Z7879-Z7928, Z7958-Z7992.

Ten more Blenheim Mk IVs were built by Valtion Lentokonetehdas at Tampere (allocated local serials BL196-205), with five more being cancelled when the Russo-Finnish armistice was signed on 4 September 1944. About 31 surviving Blenheims (including a handful of Mk Is) remained in use when the peacetime Finnish air force was re-established in 1945, but the terms of the peace treaty with Russia forbade the use of bombers and the last 13 Blenheims were stored from 1948. In 1951, however, five aircraft were resurrected as target tugs. They continued to fly with the 1st Lennosto and Test Flight until 1958, with the last aircraft (BL-199) flying until 20 May 1958. BL-200 was preserved at Luonetjärvi, moving to Jyvaskla in 1969 then to the museum at Tampere in 1979. It then went into storage at Tikkakoski and is the only European-built survivor of the breed. Z7513 was found at the Kufra Oasis in Libya in 1959, where it had force-landed in 1942 with empty tanks. Unfortunately, the aircraft was broken up for scrap in 1960, and by 1965 only the spars remained.

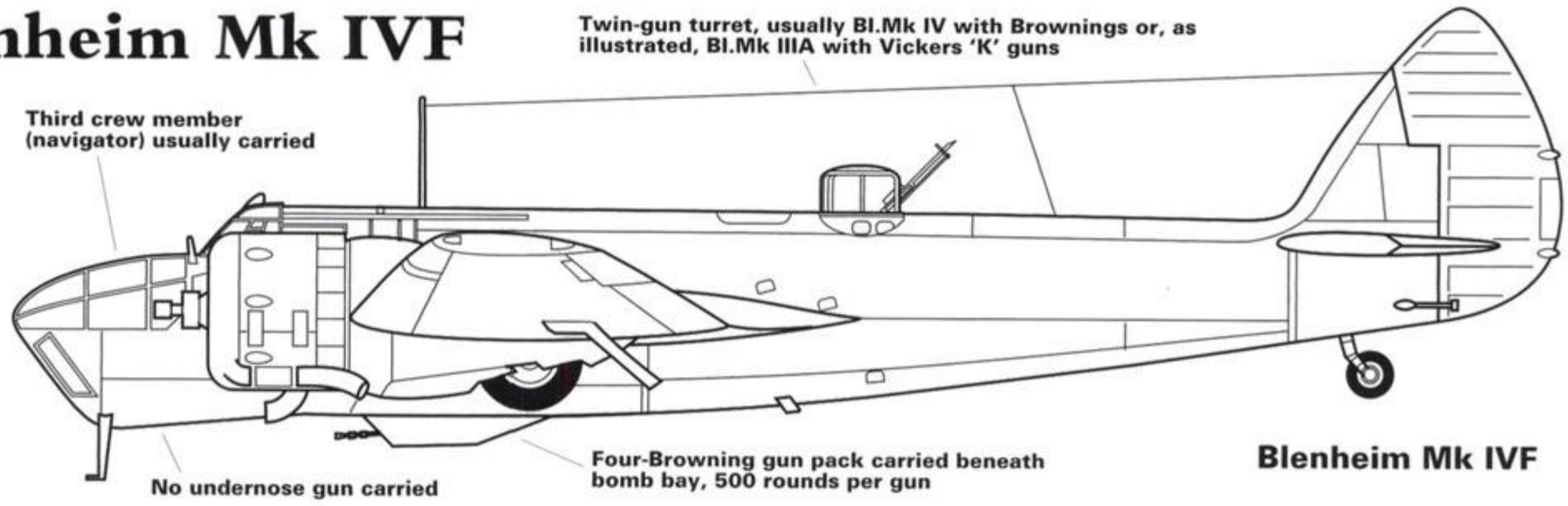
This No. 13 OTU Mk IV has the final standard of defensive armament: FN.54 undernose turret and twin-gun mid-upper turret.



Bristol 149 Blenheim Mk IVF

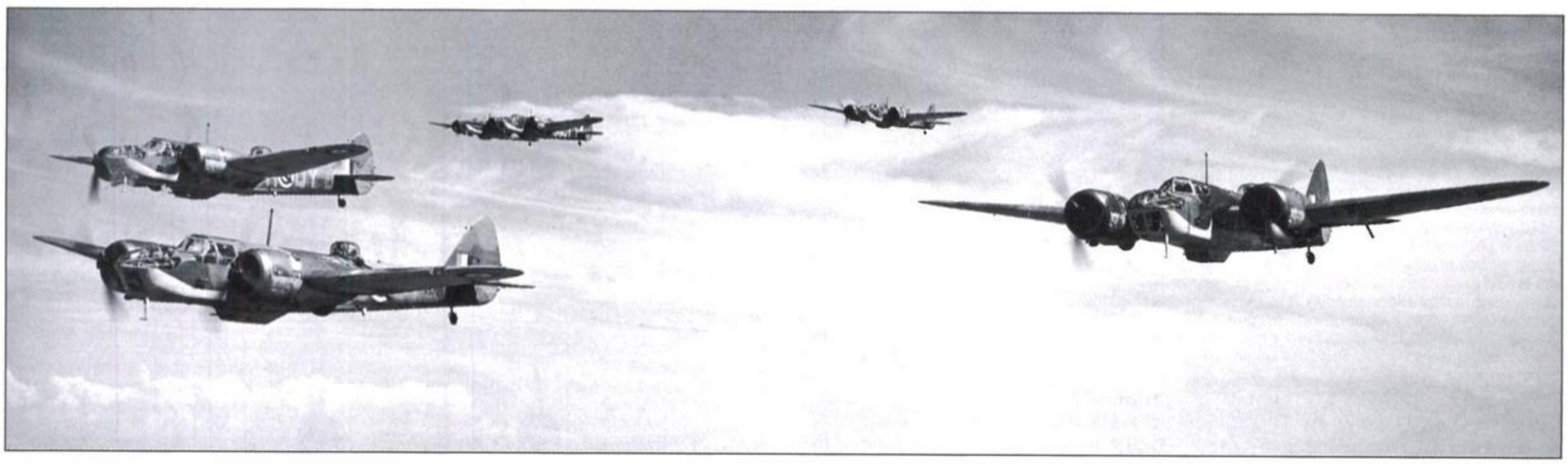
A handful of Blenheim Mk IVs was converted as fighters with ventral gun packs and sometimes with AI.Mk III radar. Blenheim Mk IVs were among the first aircraft fitted with AI radar and used for operational trials, and equipped No. 600 Squadron from November 1939. The Blenheim Mk IVF was never common within Fighter Command, although the variant was widely used by Coastal Command's Trade Protection units. These had formed with Blenheim Mk Is and IFs within Fighter Command, transferring to Coastal Command as fighter-reconnaissance units in February 1940. From May 1940 these units rapidly re-equipped with new-build and surplus ex-Bomber Command Blenheim Mk IVs, which were operated by a crew of three, adding a navigator (or more accurately an observer, at that early stage of the war) to the pilot and wireless operator/air-gunner.

When fitted with a ventral cannon tray the Blenheim Mk IVF obviously could not carry an undernose rearward-firing gun, and could not use the internal bomb bay, but the mid-upper turret was retained, often with two machine-guns fitted.


Twin-gun turret, usually Bl.Mk IV with Brownings or, as illustrated, Bl.Mk IIIA with Vickers 'K' guns
Third crew member (navigator) usually carried
No undernose gun carried
Four-Browning gun pack carried beneath bomb bay, 500 rounds per gun

Blenheim Mk IVF

Blenheim Mk IVFs of Coastal Command's No. 254 Squadron are seen on patrol in early 1942 from their base at Dyce. The Mk IVF proved a useful vehicle for light strikes against shipping and general reconnaissance duties before the harder-hitting Beaufighter joined Coastal Command ranks.

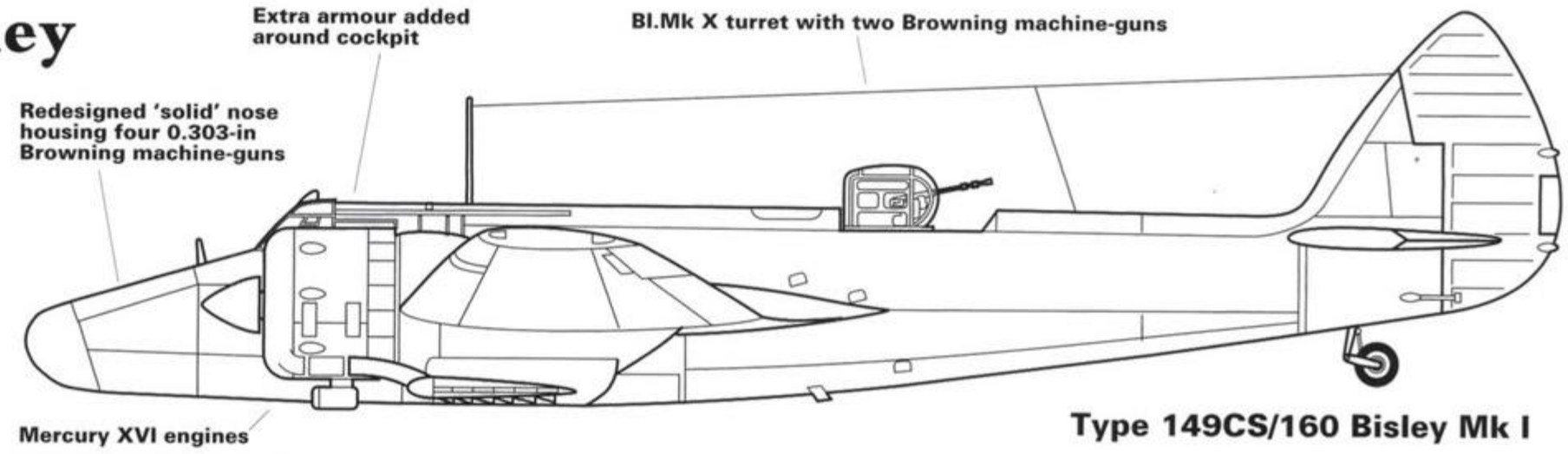


Bristol 160 Bisley

The Bristol Bisley was originally designed to meet the Air Ministry's Specification B.6/40 for a short-range dive-bomber and low-level close support aircraft. The company proposed a direct modification of the Blenheim Mk IV, but with airframe strengthening and with a new nose section containing a battery of four 0.303-in Browning machine-guns, each with 1,000 rounds, and with 600 lb (272 kg) of external armour protecting the redesigned nose. A B.Mk X dorsal turret was fitted, containing two additional Brownings. This turret could rotate continuously, and was armoured and provided with a gyro gunsight. Two Bisley Mk I prototypes were ordered, with construction numbers 9874 and 9875 (serialled AD657 and AD661). They were powered by 920-hp (686-kW) Mercury XVI engines, and were originally referred to as the Bristol 149CS and 149HA. The nose was redesigned to accommodate interchangeable cannon and medium/high-level bomber noses. The latter added a ventral canoe with a twin Browning FN.54 mounting (with 1,000 rpg) for self-defence, protecting the aircraft's vulnerable belly. The interchangeable nose plan was soon regarded as impractical, and was abandoned, and the decision was taken that the 1,195 Bisleys on order (later reduced to 940) would be delivered as Blenheim Mk V high-level bombers with glass noses.

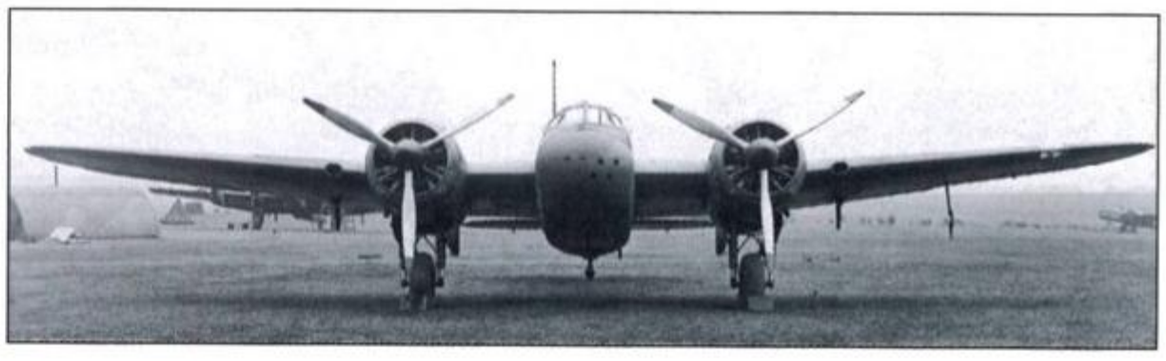
AD657 made its first flight on 24 February 1941, fitted with the originally planned (non-interchangeable) four-gun nose, while AD661 was completed to what we now know as Blenheim Mk V standards. The Bisley name was retained, and was not officially discarded until 8 January 1942.

On the Bisley, wingspan was reduced from 56 ft 4 in (17.17 m) to 56 ft 1 in (17.09 m), while the aircraft's length increased to 43 ft 4 in (13.21 m) (Bisley) or 43 ft 11 in (13.39 m) (Blenheim Mk V). This compared to the Blenheim Mk I's length of 39 ft 9 in (12.12 m) and the Blenheim Mk IV's 42 ft 9 in (13.303 m).

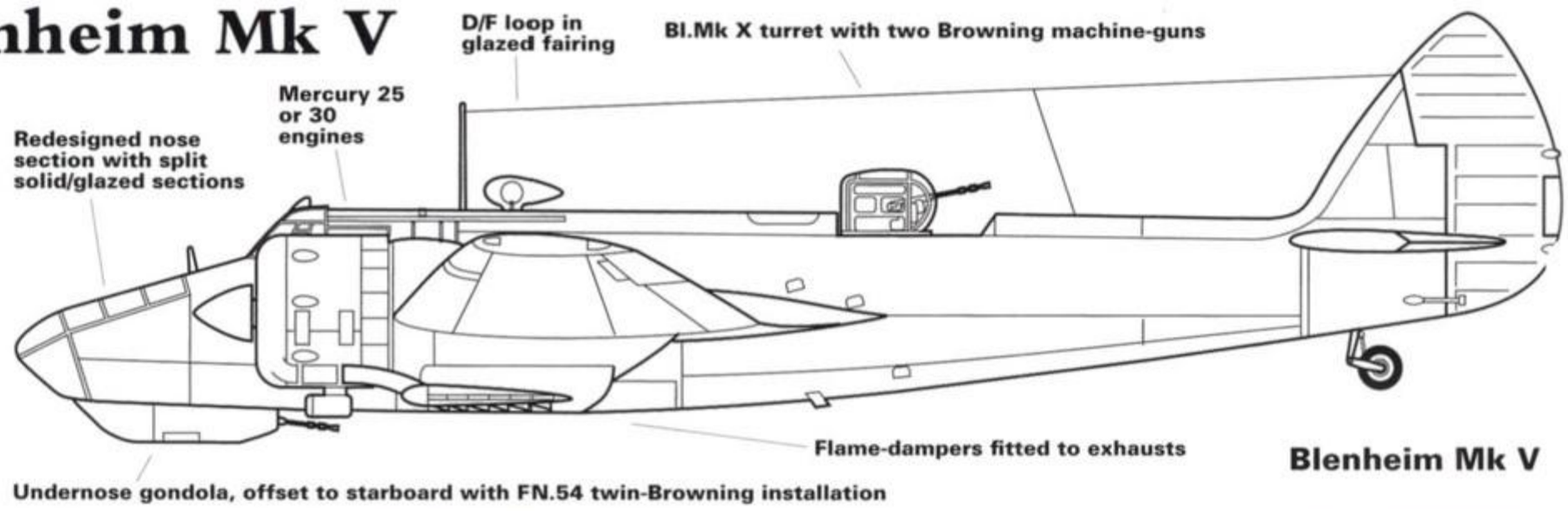

Extra armour added around cockpit
Bl.Mk X turret with two Browning machine-guns
Redesigned 'solid' nose housing four 0.303-in Browning machine-guns
Mercury XVI engines

Type 149CS/160 Bisley Mk I

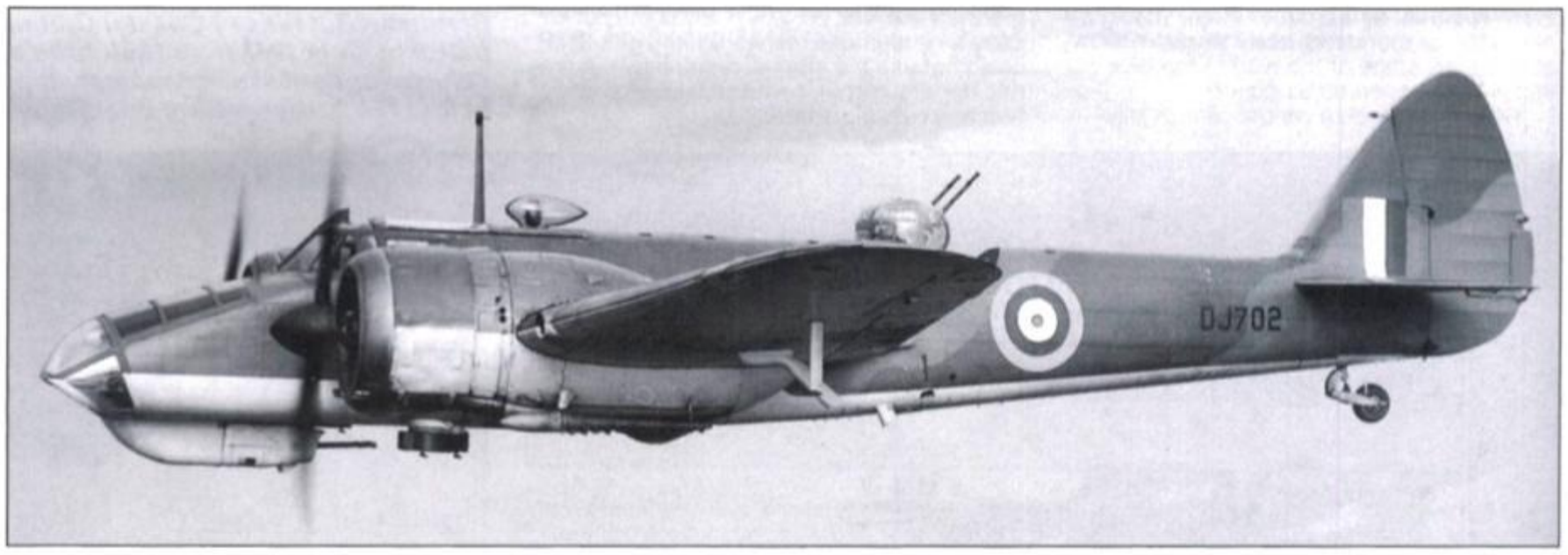
The first Bisley, AD657, is shown in original form (above) before fitment of the four-gun armament, seen right. The second prorotype was completed as a bomber, acting as the prototype for the Blenheim Mk V. The Bisley's fate was sealed by the defeat at Dunkirk, the urgent need for a close support aircraft having evaporated.



Bristol 160 Blenheim Mk V


D/F loop in glazed fairing
Bl.Mk X turret with two Browning machine-guns
Mercury 25 or 30 engines
Redesigned nose section with split solid/glazed sections
Flame-dampers fitted to exhausts
Undernose gondola, offset to starboard with FN.54 twin-Browning installation

Blenheim Mk V



Above: DJ702 was the first pattern aircraft for the Blenheim Mk V.

Right: The unusual nose design of the Mk V is evident here. Bombs were aimed from the port side of the nose, through the flat-pane lower window.

By the time the Bristol 160 entered service, the name Bisley had been officially dropped, but remained in widespread use. When the first Rootes-built pattern aircraft (DJ702 and DJ707) emerged they were to all intents and purposes Blenheim Mk Vs, based as they were on the configuration of the second Type 149HA Bisley prototype, but they were officially still known as Bisley Mk Is. Mercury 25s rated at 840 hp (627 kW) at low altitude powered the aircraft (ordered in January 1941). It was not until November 1941 that Bristol suggested that they should instead be known as Blenheim Mk Vs.

The production Blenheim Mk V discarded the external armour plate fitted to the prototype, though the provision of oxygen and new radios meant that the aircraft was no lighter. The radio suite consisted of a TR9F for voice communications, a T.1154/R.1155 controlled by the rear gunner/weapons operator, another R.1155 with a direction-finding loop for the navigator and an R.3003 IFF set.

Empty weight reached 11,000 lb (4990 kg) (the Blenheim Mk IV weighed in at 9,800 lb/4445 kg, and the Blenheim Mk I at only 8,100 lb/3674 kg) and all-up weight climbed to 17,000 lb (7711 kg), necessitating the provision of a strengthened undercarriage and beefed-up spar webs. This made the Blenheim Mk V the slowest member of the family, with a maximum speed of only 260 mph (418 km/h), despite the more powerful 950-hp (709-kW) Mercury 25 or 30 engines used by the production aircraft, and despite its lower drag characteristics. Except at very low weights, the Blenheim Mk V was unable to maintain height on one engine. The Blenheim Mk V incorporated a host of minor refinements, including fully enclosed main undercarriage wells, covered by hinged doors. On earlier versions, the rear part of the wheel projected down into the airflow uncovered.

Some 942 Blenheim Mk Vs were built by Rootes Securities of Blythe Bridge, Staffordshire, most being tropicalised Type 160D Mk VDs with 950-hp Mercury 25 or Mercury 30 engines and Vokes filters. Bomber Command's No. 2 Group was by then trading its Blenheim Mk IVs for Bostons and Venturas, and the Mosquito was on the horizon, so, apart from brief service as an interim aircraft with No. 139 Squadron between June and October 1942, the Blenheim Mk V found itself relegated to training duties and overseas commands.

The Mk VD was externally identifiable because its tropical equipment necessitated the relocation of the air gunner's T.1154/R.1155 to the navigator's station, causing a slight bulge in the roof lines, dictating the provision of an extra aerial mast in front of the cockpit. The Type 160T Mk VC was a dual-control trainer (which often had its rear turret and underfuselage ventral gondola removed), while the Mk VA (Type 160HA) was the non-tropicalised bomber, and the Mk VB (Type 160CS) designation was reserved for the unbuilt close support variant having spinners on the airscrew hubs.

The Mk V formed the basis of a number of in-service modified versions. Blenheim Mk Vs were used in the coastal/general reconnaissance role in the Middle East, while in India Mk Vs saw service as air ambulances. At least one was modified for the survey role, with a Fairchild K.17 and an F.24 with a 5-in lens.

Towards the end of their front-line service in North Africa, some Blenheim Mk V bombers had their undernose gondolas, observer's radio, survival water tanks and remaining armour removed, making them appreciably faster and at last able to maintain height on one engine. Even without armour, the Blenheim was rugged: aircrew survived some astonishing crashes and aircraft limped home even after absorbing considerable battle damage (on at least one occasion after receiving 57 20-mm cannon shell direct hits!).

Serialled AZ861-AZ905, AZ922-AZ971, AZ984-AZ999, BA100-BA118, BA133-BA172, BA191-BA215, BA228-BA262, BA287-BA336, BA365-BA409, BA424-BA458, BA471-BA505, BA522-BA546, BA575-BA624, BA647-BA691, BA708-BA757, BA780-BA829, BA844-BA888, BA907-BA951, BA978-BA999, BB100-BB102, BB135-BB184, DJ702, DJ707, EH310-EH355, EH371-EH420, EH438-EH474 and EH491-EH517, Mk V production ended in July 1943, with the original 1,195-strong order having been reduced to 940.

Relatively large numbers of Blenheim Mk Vs were exported to Turkey, and more were acquired by Portugal when they force-landed there en route to North Africa. These aircraft were purchased rather than interned. A Greek squadron, No. 13, also used a handful of Blenheim Mk Vs in the maritime role, though it came under RAF command, and the type was also used in small numbers by the Free French. Four Blenheim Mk Vs (BB179, EH347, EH443, and EH458) were also briefly used by the USAAF in North Africa.

The Mk V found little front-line employment at home, but saw significant service in the Mediterranean and Far East. The hefty Bl.Mk X turret offered armoured protection for the gunner and a stout defence against fighters, but imposed a considerable weight penalty which added to the overall performance loss.

Bolingbroke Mk I

Eighteen Blenheim Mk IVs were manufactured by Fairchild of Longueuil as RCAF 702-719. These aircraft were built using Bristol drawings and imported components and sub assemblies. Although equivalent in most respects to the long-nosed Blenheim Mk IV, the aircraft retained the 840-hp (627-kW) Bristol Mercury VIII engines of the Blenheim Mk I. The Bolingbroke name originally applied to the first long-nosed variant (see the first Bristol 149 entry, above) was revived for these Canadian-built aircraft. RCAF 705 was subsequently converted to Bolingbroke Mk II configuration, while another, RCAF 717, was converted to become the sole Bolingbroke Mk III.

The Bolingbroke Mk Is served with No. 119 Squadron from July 1940, and were converted to fighter configuration with the addition of a four-gun ventral cannon pack. The aircraft were transferred to No. 115 Squadron in August 1941.

714 was among the first batch of Bolingbroke Mk Is built by Fairchild. Many of this batch subsequently received four-gun belly packs.

Bolingbroke Mk II

A single Bolingbroke Mk I (RCAF 705) was badly damaged in an accident during an early test flight. While being repaired, this aircraft was converted to Bolingbroke Mk II configuration with US equipment and instruments.

Bolingbroke Mk III

The single Bolingbroke Mk III (RCAF 717) was converted to floatplane configuration, having originated as a standard Bolingbroke Mk I. The aircraft was subsequently brought back to landplane configuration.

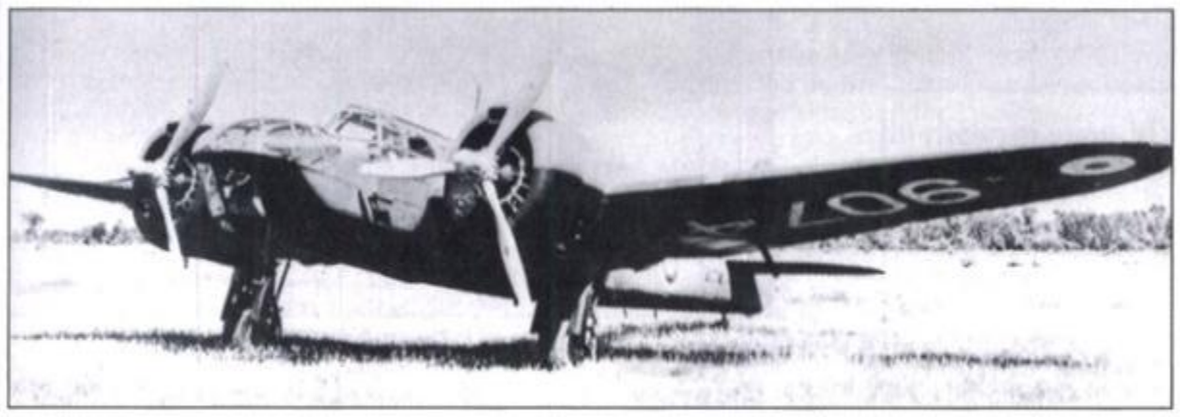
Right: The single Mk III floatplane was converted in 1942 with Edo floats. It was employed for some time by No. 5 Squadron, a Canso operator based on Canada's east coast for anti-submarine patrols.

Bolingbroke Mk IV

Fairchild of Longueuil built 185 aircraft, with 920-hp (686-kW) Bristol Mercury XV or XX engines, as used by RAF Blenheim Mk IVs. These aircraft, serialled RCAF 9001-9201, were designated as Bolingbroke Mk IVs. Used in the coastal/general reconnaissance role, the aircraft had dinghies fitted, together with de-icing boots on the wing and tail unit leading edges, and had provision for an interchangeable skid landing gear. Fifteen of the total (RCAF 9005 and 9010-9023) were built as Mk IV-W, one more (RCAF 9074) being converted as the sole Mk IV-C.

Operational Bolingbrokes served with No. 119 Squadron from July 1940, and with Nos 8, 13, 115, 121, 122, 147 and 163 Squadrons. Nos 8 and 115 Squadrons participated in the Aleutians campaign (some receiving SEAC-style blue/white roundels), making one contact with an enemy submarine in July 1942.

This Bolingbroke Mk IV is seen modified for the target-tug role, with black/yellow striping.



Bolingbroke Mk IV-C

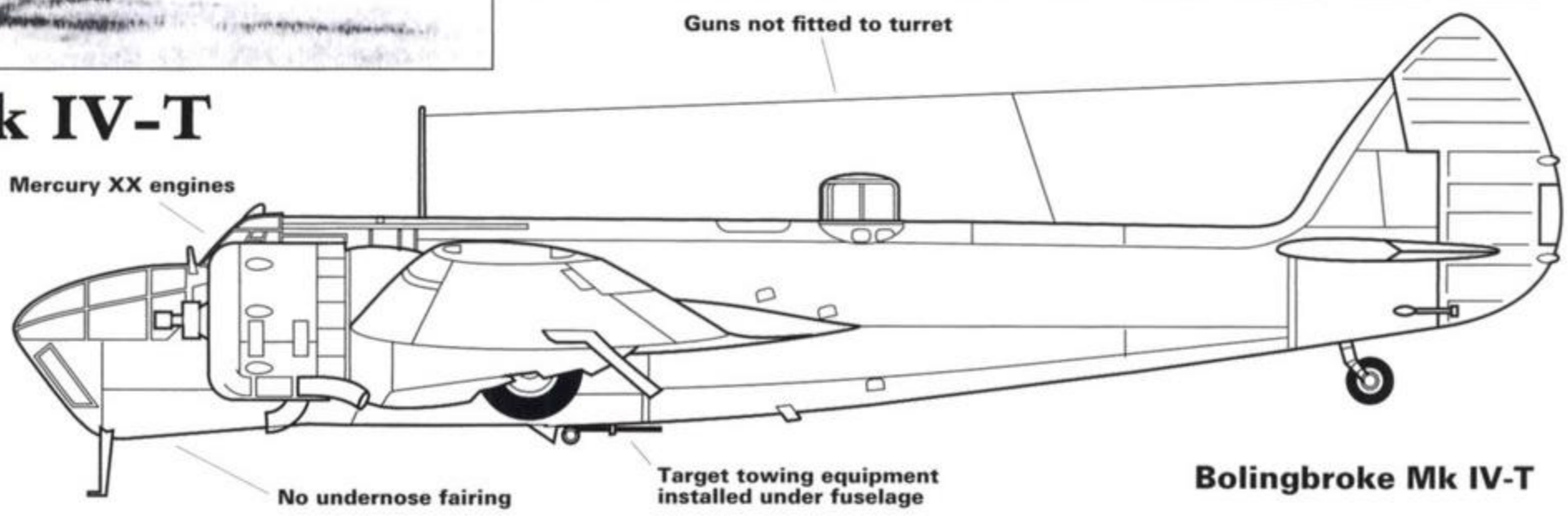
The shortage of 100-octane fuel in Canada led to a search for an alternative powerplant.

Left: The Cyclone powerplant of the Mk IV-C required fatter, shorter nacelles than the Mercury.

One aircraft (RCAF 9074) was therefore fitted with 850-hp (634-kW) Wright Cyclone G3B engines. These gave better performance with 93-octane than did the Mercury XV, but the Mercury XX worked just as well, and became the standard powerplant for the Bolingbroke Mk IV.

Bolingbroke Mk IV-T

The last 457 Canadian aircraft (including 51 unserialled spare airframes), with serials RCAF 9851-10256, were completed as Bolingbroke Mk IV-T navigation and gunnery trainers, most (or at least from 10200, according to some sources) powered by 920-hp (686-kW) Mercury XX engines. Some were used as target tugs, and were painted in black and yellow stripes overall. Some of the trainers wore an overall yellow scheme. The trainer aircraft served throughout the war, and most were then sold off as surplus. The majority were scrapped, but a handful briefly continued in forestry and survey duties.



Bolingbroke Mk IV-T

Bolingbroke Mk IV-W

As the Battle of the Atlantic raged, the possibility of disruption to the supply of Mercury engines – and the need to avoid unnecessary use of Transatlantic ship capacity – prompted Fairchild to examine a change to locally produced engines. Fifteen Bolingbroke Mk IVs (RCAF 9005 and 9010-9023) were thus fitted with 750-hp (560-kW) Pratt & Whitney Twin Wasp Junior SB4G engines.

Twelve of the 15 Bolingbroke Mk IV-Ws are seen lined up at the Fairchild plant at Longueuil, Montreal, displaying the revised nacelle contours dictated by the Twin Wasp Junior engine.

Blenheim operators

United Kingdom

Royal Air Force – home: The Blenheim first went into service as a day bomber, seeing service in France. It was rapidly superseded in Bomber Command by larger and more capable types, and many were transferred to Coastal Command for maritime work such as shipping escort duties. The Mk IF filled a brief but important gap as an interim night-fighter before sufficient Beaufighters became available, and was instrumental in the development of AI radar while serving with the Fighter Interception Unit.

In addition to the numbered squadrons, Blenheims served with a wide range of second-line and training units, especially after they had been replaced in the front-line. Individual aircraft were operated on occasion by other squadrons for various purposes: these are not listed below. UK-based squadrons known to have been equipped with Blenheims were, by role and variant:

Fighter Command – 23 (IF), 25 (IF and IVF), 29 (IF), 64 (IF), 68 (IF), 92 (IF), 141 (IF), 145 (IF), 219 (IF), 222 (IF), 229 (IF), 234 (IF), 242 (IF), 245 (IF), 248 (IF and IVF), 254 (IF), 406 (RCAF – I and IV), 600 (IF and IVF), 601 (IF), 604 (IF)
Bomber Command – 15 (IV), 18 (I, IV and V), 21 (I and IV), 34 (I), 35 (IV), 40 (IV), 44 (I), 57 (I and IV), 61 (I), 82 (I and IV), 88 (IV), 90 (I and IV), 101 (I and IV), 104 (I and IV), 105 (IV), 107 (I and IV), 108 (I and IV), 110 (I and IV), 114 (I, IV and V), 139 (I, IV and V), 144 (I), 218 (IV), 226 (IV)
Coastal Command (including PR) – 59 (IV), 86 (IV), 140 (IV), 143 (IVF), 212 (IV), 235 (IF and IVF), 236 (IF and IVF), 248 (IF and IVF), 252 (IF and IVF), 254 (IF and IVF), 272 (IVF), 404 (RCAF – IVF), 407 (RCAF – IV), 415 (RCAF – IV), 489 (RNZAF – IV), 608 (IV)
Army co-operation – 13 (IV), 53 (IV), 59 (IV), 614 (IV and V)
Anti-aircraft co-operation – 285 (I and IV), 287 (IV), 288 (IV), 289 (IV)
Calibration – 526 (IV), 527 (IV), 528 (IV)
Meterological reconnaissance – 521 (IV)
Combined operations (army support/training) – 516 (IV)

Royal Air Force – overseas: Perhaps the Blenheim's greatest contribution to the Allied war effort came overseas, where it could operate more effectively than in northern Europe, where defences and fighters were more intense and more effective. The Blenheim formed the backbone of the overseas light bomber force for much of the war, and also provided interim night-fighting elements. Overseas squadrons were, by theatre:

Mediterranean/Middle East/North Africa – 6 (IV), 8 (I, IV and V), 11 (I and IV), 13 (V), 14 (IV), 18 (IV and V), 30 (I and IF), 38 (I and IF), 39 (I and IV), 45 (I), 52 (IV), 55 (I and IV), 84 (I and IV), 113 (I and IV), 114 (V), 162 (IV and V), 173 (IV), 203 (I and IV), 211 (I and IV), 223 (I), 244 (IV and V), 454 (RAAF – IV and V), 500 (IV and V), 680 (IV), 15 SAAF (IV and V), 16 SAAF (V), 17 SAAF (V), 13 Greece (IV and V)
Far East/India – 11 (I and IV), 20 (I), 27 (IF), 34 (I, IV and V), 39 (I), 42 (IV and V), 45 (I and IV), 60 (I and IV), 62 (I), 84 (IV), 110 (IV), 113 (IV and V), 211 (IV)

Mk Is are seen in April 1939 arriving at Khormaksar in Aden to augment the Vincent biplanes of No. 8 Squadron.

No. 248 Squadron alternated between Fighter and Coastal Commands. It operated gun-armed Blenheims on fighter patrols and anti-shipping attacks.

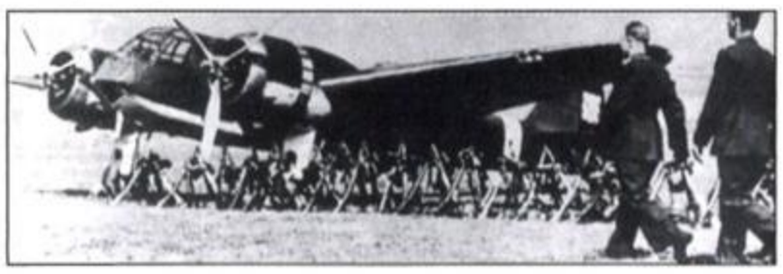
Royal Navy: The Fleet Air Arm received at least 16 Mk Is and 72 Mk IVs by transfer from the RAF, for use in a variety of second-line duties. They served with the following squadrons:
Training – 748 (IV), 759 (IV), 762 (IV), 780 (I and IV), 798 (IV)
Fleet requirements – 770 (I and IV), 771 (I and IV), 772 (IV), 775 (IV), 776 (I and IV), 788 (IV)
Fighter trials – 787 (I and IV)

Foreign operators

Canada: The RCAF units which formed in Europe are listed under the United Kingdom entry. RCAF home use began with the delivery of Bolingbroke Mk Is to No. 8(BR) Squadron from November 1939. This bomber-reconnaissance unit was employed primarily on anti-submarine patrols. Other squadrons to adopt the Bolingbroke were No. 115 (Fighter and BR), Nos 119 and 147 (Bomber Reconnaissance), Nos 121 and 122 (Composite) and No. 163 (Army Co-operation). No. 5(BR) Squadron operated the single Bolingbroke Mk III floatplane. In April 1942 No. 115 Sqn took its gunpack-equipped Bolingbrokes to Alaska to bolster the US defences there. No. 8 Sqn also served in Alaska. The Bolingbroke was also widely used in the British Commonwealth Air Training Plan. The fleet was mostly scrapped at the end of the war, but a number survived in second-line and training duties.

Apart from its licence-built Bolingbrokes, the RCAF was allocated nine D/F-equipped aircraft from an early Filton production batch, and actually received seven aircraft transferred from RAF stocks, consisting of L9309, 9311, 9312, 9376, 9377, 9380 and 9384.

Croatia: A handful of surviving Yugoslav Blenheims was briefly incorporated into the Croatian air force.



The red and white shield on the fin identifies this Mk I as a Croatian aircraft.

Finland: Finland ordered 18 Blenheim Mk Is in October 1936, and these (Filton-built c/ns 8137-8154), modified to carry Swedish-supplied bombs, were delivered as BL104-BL121, equipping a new regiment at Immola. Used for bombing and reconnaissance, the Finnish Blenheim Mk Is soon exchanged their British Eagle Mk IV cameras (prone to icing) for Zeiss RMK 20 and RMKS 50 cameras. Despite this, Finland was pleased with its Blenheims and ordered more. Twelve Filton-built Mk IVs were ordered as BL122-133, and delivered in January 1940, though one of these was damaged before delivery and delayed, one ditched in the North Sea and was lost (BL127), and one landed in Norway. Twelve Mk Is built by A.V. Roe at Chadderton (L6764-L6773) went to Finland as BL134-145 in February 1940. To avoid Russian protests, the Blenheims were delivered by volunteer RAF crews in civilian clothes, and were repainted as civil aircraft. Valtion Lentokonetehdas at Tampere in Finland eventually built 45 Blenheim Mk IIs, allocating the local serials BL146-BL190. Ten more Blenheim Mk IVs were built by Valtion Lentokonetehdas at Tampere (allocated local serials BL196-205), with five more Blenheim Mk IIs (BL190-195) being cancelled when the Russo-Finnish armistice was signed on 4 September 1944. A handful of Blenheim target tugs served until 1958.

BL-136 was one of the second batch of Finnish Mk Is, arriving in February 1940.

Blenheims survived in Finnish service long after the war's end. This Mk II was seen in the late 1950s.

Finnish Blenheims, like this Mk IV, were regularly fitted with skis for winter operations.

France: The first Free French Blenheim unit (Escadrille Topic) formed on 1 August 1940 and trained at Odiham and Andover before moving to North Africa in October to form part of Groupe Reserve de Bombardement 1 (GRB 1), formed on 24 December 1940 and included 14 Blenheim Mk IVs. Serviceability was poor, and, despite receiving some replacements, strength was down to two aircraft by the autumn of 1941.

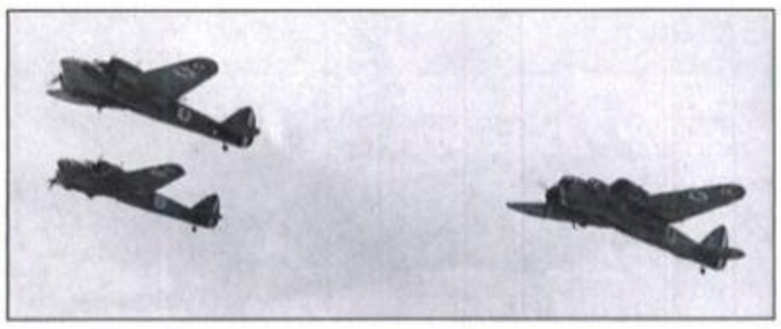
In September 1941 GRB 1 was re-equipped and incorporated into the new Groupe de Bombardement 'Lorraine', with two squadrons ('Metz' and 'Nancy') equipped with 21 ex-RAF Blenheim Mk IVs. In early 1942, 'Lorraine' withdrew to rest and regroup in Syria. In August 1942, 'Metz' was seconded to RAF Coastal Command, and began to re-equip with Blenheim Mk Vs, but the group re-equipped in October 1942.

Groupe de Bombardement 'Bretagne' had meanwhile formed in Chad in January 1942, operating a mix of Blenheim Mk IVs and Martin 167s in support of Free French ground forces pushing into Tunisia. It began converting to Marauders in September 1943.

In addition to the Blenheim Mk IVs with which they are usually associated, the Free French bomber units also later used a handful of Blenheim Mk Vs, although they were mainly used in the coastal surveillance role by 'Metz' and by Groupe 1/17 'Picardie', and included BA306, BA324, BA326, BA394, BA443, BA525, BA596, BA849, BA866 and BA994.

Groupe 1/17 'Picardie' was operational from June 1943 until August 1945, and was the last French operator of the Blenheim.

Free French Mk IVs wore the large cross of Lorraine as well as red/white/blue roundels and fin flashes.



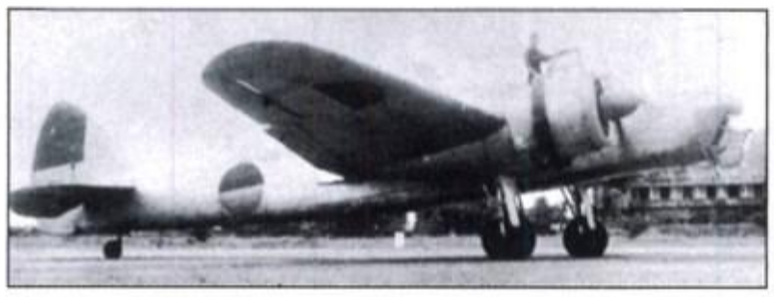
Germany: At least one Blenheim Mk IV was captured, presumably in France, and flown in Luftwaffe markings. It wore the codes '5-5'.

The Luftwaffe operated a number of captured Allied types for exhibition purposes, including this Mk IV.

Greece: Greece received 10 new-build Blenheim Mk IVs from the Filton production line, delivered unarmed as G-AFXD to G-AFXO between October 1939 and February 1940. These equipped 32 Ira Vomvardismou and were augmented in April 1941 by six Blenheim Mk Is transferred from RAF stocks, including L6658, L6670, L8384 and L8385. They were lost during the German invasion. A Greek-manned unit operating under RAF control, No. 13 (Hellenic) Squadron operated Blenheims from October 1942 until September 1943, when it converted to Baltimores. Its aircraft included Mk Vs BA106, BA165, BA167, BA290, BA294, BA304, BA343, BA384, BA395, BA399, BA403, BA429, BA454, BA487, BA544, and BA580. BA581, BA593, BA847, BA848, BA850, BA882, BA912, BA929, BA934, BA937, BA948, EH316, EH319, EH336, EH338 and EH405.

Hungary: A single ex-Yugoslav Blenheim Mk I was flown to Hungary by a pilot of Hungarian extraction in April 1941. The aircraft subsequently became L-104 with the Hungarian air force and flew in the transport role for most of the war.

Indonesia: One Blenheim Mk IV captured by the Japanese was taken over by Indonesian rebels after the war and was refurbished and modified for the survey role. After being fitted with Japanese 950-hp (708-kW) Nakajima Sakae engines, the machine crashed on its first flight.



The sole Sakae-engined Mk IV is seen at Masupati in 1946, shortly before its crash.

Portugal: Some 20 ex-RAF Blenheim Mk IVs (including N3544, N3600, R2775, R2781, R2799, T2431, T2434, V5429, V5434, V5501, V5729, V5883, V6395, Z5736, Z5760, Z5762, Z6030, Z6035, Z6341 and Z7492) and three Blenheim Mk Vs (AZ986, AZ987 and BA826) were handed over to Portugal as a result of the Azores treaty, which provided that serviceable aircraft landing in Portugal would be handed over and provisioned with spares, but that their crews would be quickly repatriated. These 'windfall' aircraft formed Esquadrilha ZE at BA 2. Twelve Blenheim Mk IVFs were also supplied to equip the Portuguese Navy's Esquadrilha B das Forças Aéreas da Armada, and were later transferred to Air Force control.

This Portuguese Blenheim line-up includes Mk IVs and a single Mk V (right).

Romania: The Romanian air force received several batches of Blenheim Mk Is before the outbreak of war, including L8619 and L8620 on 17 May 1939, L8603-8608 on 13 June, L8622, L8624-8630, L8632 and L8652-8654 on 20 June, and L6696-L6708 and L6713-6718 on 26 June. These deliveries totalled 39 aircraft. Some 13 more Blenheims (L6696-L6708 built by A.V. Roe at Chadderton) were delivered in November 1939, in a vain hope of persuading Romania to join the Allies. Some of these aircraft were still in use in August 1944, operating under Luftwaffe command.

South Africa: The SAAF evaluated a single Blenheim Mk I, L1431, during 1939.

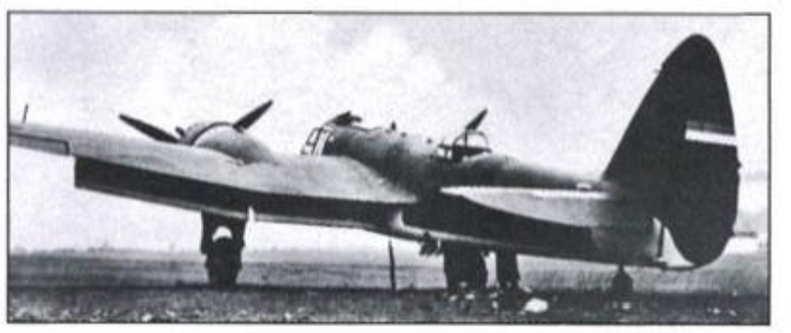
Turkey: Turkey eventually became the second largest foreign operator of the Blenheim (after Finland), with at least 56 aircraft delivered. Turkey received an initial batch of 12 Filton-built Mk Is from October 1937 (c/ns 8155-8166, delivered as G-AFFP to G-AFFZ, then reserialled as 2501-2512), with 18 more being delivered from November 1938 (c/ns 9222-9239 delivered as G-AFLA to G-AFLS, reserialled after delivery as 397-408 and 485-490, and then as 2513-2530). During the next three years, neutral but helpful Turkey received a steady trickle of Blenheims from RAF stocks, beginning with 10 Mk Is on 21 September 1939 (L1483, L1485, L1488, L1489, L1493, L4821, L4824, L4826 and L4824, locally serialled 2531-2540). Other aircraft delivered included Mk IVs BR892, 893 and 895 (serialled 2541-2543), then later T1996 and Z7986 (local serials unknown). In 1943 Turkey received 19 Mk Vs (locally serialled 3901-3919) including BA137, BA292, BA495, BA591, BA613, BA614, BA713, BA854, BA855, BA887, BA910, BA922, BA925, EH320, EH326, EH341 and EH372, with other possible candidates sometimes quoted as including BA488.

The Mk I was numerically the most important to Turkey. These are from the first batch delivered in 1937.

Turkey received 19 Mk Vs from RAF stocks.

USA: The USAAF in North Africa briefly used four Blenheim Mk Vs (BB179, EH347, EH443 and EH458), from 1 October 1943.

Yugoslavia: Two Filton-built Mk Is (c/ns 8814 and 8815) were delivered to Yugoslavia as G-AFCE and G-AFCF in November 1937 to act as pattern aircraft for Yugoslav licence-production by Ikarus AD at Zemun, which was planned to comprise 50 Mk Is. Ikarus eventually built 16 Blenheim Mk Is; 24 more aircraft under construction were destroyed by partisans before completion to prevent them falling into enemy hands. In February 1940 the locally-built Blenheims were augmented by 20 Mk Is built by A.V. Roe at Chadderton and withdrawn from RAF stocks at the MU at Aston Down (these were L6813, L6814 and L6817-L6834, delivered to Yugoslavia as YU-BAA to YU-BAT). Some of the ex-RAF aircraft delivered to Yugoslavia were fitted with twin forward-firing 20-mm cannon, and served in the fighter role. Some sources suggest that Yugoslavia received as many as 56 or 62 Blenheims, equipping 21, 22, 201, 202, 203, 204, 215, 216, 217 and 218 Eskadrilas (flights).



Yugoslavia's Mk Is were a mix of ex-RAF and locally built aircraft. The fin-flash was red, white and blue.

Blenheim survivors

No short-nosed Blenheim survives, although the discovery of a Blenheim Mk I nose converted as a 'bubble car' may lead to the British Aerial Museum eventually restoring a hybrid Blenheim Mk I/Bolingbroke Mk IVT. Only one European-built Mk IV, the Finnish BL-200, survives, as part of the Finnish air force collection.

The Bolingbroke Mk IV-T provided the remainder of the world's surviving Blenheims (and 42 of these are listed in Paul Coggan's *Warbirds Worldwide Directory*). In 1963 the semi-derelict 9892 was presented to the RCAF Museum by its owner, Mr George Maude, for restoration and preservation. It now wears the markings of No. 8 Squadron, RCAF, with the codes 'YO-X'. Another aircraft (10001) was acquired for the RAF Museum in 1969, and was refurbished for static display by apprentices at the A&AEE Boscombe Down in the mid-1970s before going on display at Hendon. This aircraft now masquerades as Blenheim Mk IV L8756 'XD-E' of No. 139 Squadron. Another two (9940 and the less complete 10201, together with the wings of 9703) were acquired by the Strathallan Collection, 9940 being refurbished for static display and subsequently going to the Royal Scottish Museum of Flight. By the 1970s, a handful of derelict Bolingbrokes still lay at various farms in Canada, several of them (at least 15) owned by an eccentric collector, Wes Agnew. British warbird collector Ormond Haydon-Baillie purchased the best two (9896 and 10038, plus parts from other aircraft, including 9893) in 1973, and 10038 (with the centre-section of 9893) formed the basis of the first of two successive flying Blenheim restorations undertaken at Duxford, flying on 22 May 1987 as G-MKIV, and painted up as 'Hughie' Edwards' V6028 'GB-D' of No. 105 Squadron. The aircraft was damaged beyond repair on 21 June 1987 at Denham, but a second flyable Blenheim (G-BPIV) was produced mainly from Strathallan's 10201 and 9703. This aircraft flew on 18 May 1993, initially painted up as Max Aitken's Z5722 'WM-Z' of No. 68 Sqn. In 1995 the aircraft was repainted as L8841 'QY-C' of No. 254 Squadron and in 2000 a repaint as R3821 'UX-N' of No. 82 Sqn was completed.

Other complete Bolingbrokes include RCAF 9048, being restored for static display at Chino, 9073 (N4260C) and 9983 (N4311C) with Kermit Weeks, 9104 at the BC Aviation Museum, painted as 'KB-L', 9895 with the Royal Netherlands Air Force Museum, and 9896 (dismantled) with the Canadian Museum of Flight and Transportation. Another unidentified Bolingbroke has been restored to static display standards in Belgium.

The two flying 'Blenheims' to survive, and all but one of the static exhibits, are all Bolingbroke Mk IV-Ts. Above is the ill-fated G-MKIV, which crashed after a month of flying, while below is G-BPIV, based at Duxford and active on the European show circuit.

Valtion-built BL-200, of the Finnish air force museum, is the only genuine Blenheim to survive.

Air Combat

Martin P4M Mercator

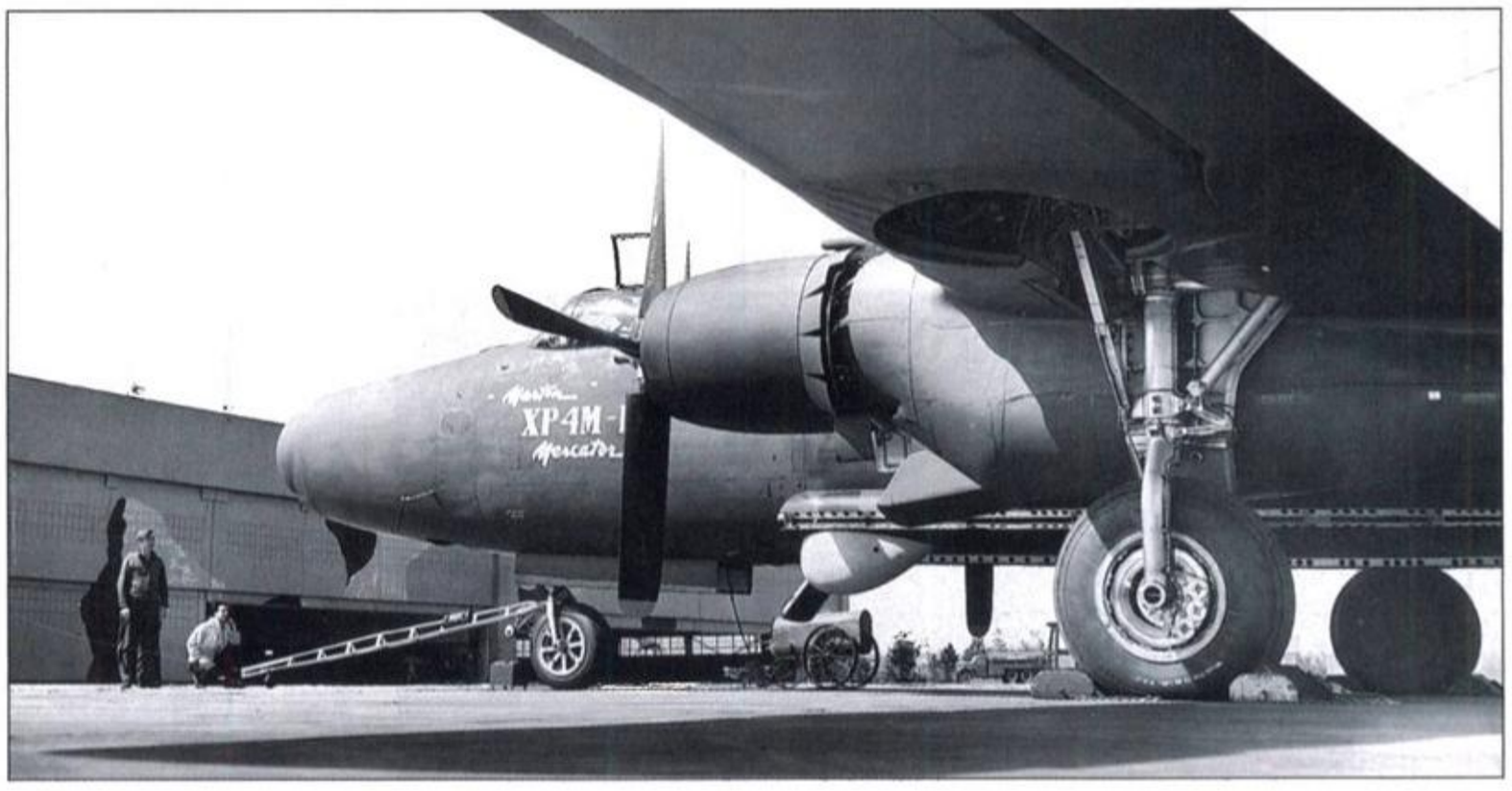
Main picture: One of VP-21's P4M-1s cruises over the harsh Moroccan landscape, sometime during the squadron's deployment to Port Lyautey.

Bottom: The first of two XP4M-1 prototypes stands on the ramp at Middle River. Note the size of the aircraft's engine nacelles, housing four-row Pratt & Whitney R-4360 radials and an Allison J33 turbojet.

Cold War Elint-gathering operations

For 10 years the Mercator was one of the most important weapons of the Cold War, though few people outside the US Navy reconnaissance community (and possibly the Russian PVO) had any idea of the aircraft's purpose – which was to spy. Snooping along the borders of the Soviet Union and its client states, Mercators monitored radar transmissions, crossing the fragile unmarked frontiers, sometimes inadvertently, sometimes deliberately. Their aircrews were prepared to pay a high price. One Mercator was shot down by Chinese MiGs, and another limped home after an attack by North Korean fighters, so badly damaged that it never flew again. There is no truth to rumours that two more losses resulted from hostile action, but the rumours highlight the risk Mercator crews faced in the air. Their tribulations, and their achievements, were remarkable for a front-line fleet of only 19 aircraft.

Martin's P4M-1/P4M-1Q Mercator (Model 219) is an aircraft about which much is misunderstood. Similar in appearance to the better-known, smaller, twin-engined Lockheed Neptune, the Mercator was a four-engined monster, its wing-mounted nacelles accommodating two 3,250-hp (2424-kW) Pratt & Whitney R-4360-20 Wasp Major radials and a pair of 4,650-lb st (20.68-kN) Allison J33-A-10 turbojets. The latter were full-scale, 'proper' jet engines, as used by the F-80 Shooting Star, and were not merely low-thrust take-off boosters. The jet engines were intended to be used during take-off and whenever necessary to 'enhance survivability'. With 'two turning and two burning', the mighty Mercator could achieve 400 mph (643 km/h) in level flight (100 mph/161 km/h more than early Neptunes), and at low level could climb faster than many



Right: The first Mercator made its maiden flight on 20 September 1946 fitted with a large forked instrumentation probe.

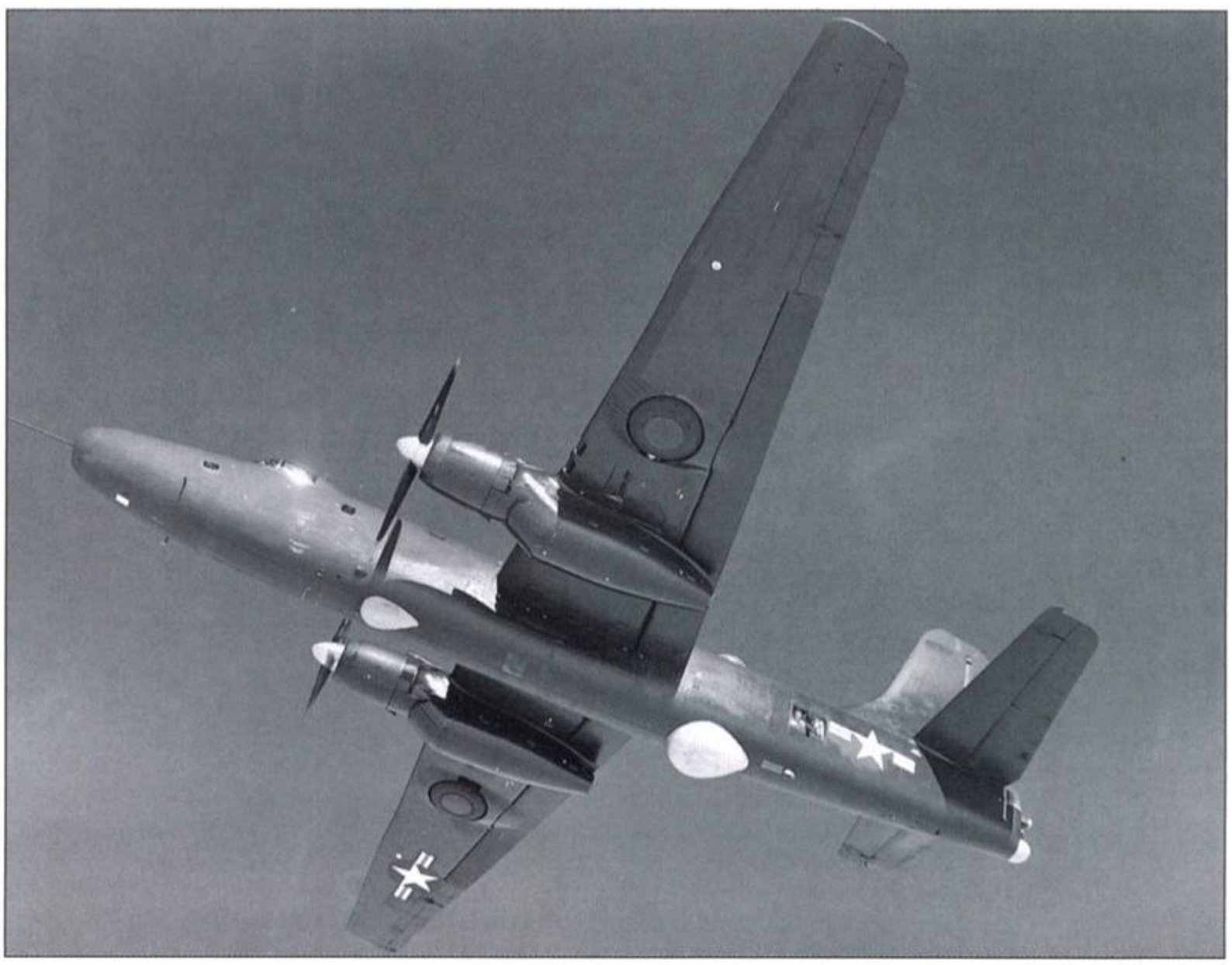
Below right: BuNo. 02790, the second XP4M-1, was completed with a mock-up nose radome and provision for only tail armament.

Below: BuNo. 02789 is prepared for another test flight on 11 February 1947. Note the Martin A-30 aerofoil testbed aircraft in the background.

Below: By 1948 the first aircraft had been modified to a configuration more closely resembling that of the production standard Mercator. A longer nose, taller tailfin, dummy radomes and a new instrumentation probe were fitted.

contemporary fighters. The undercarriage lay flat in the wing, and not in the engine nacelles, so they were still remarkably compact, and the Mercator looked very much like a twin-engined aircraft.

The Mercator was conceived in 1944 as a replacement for the Consolidated PB4Y Privateer, and particularly for the specific role of minelaying during the attack on, and invasion of, Japan. The Neptune, on the other hand, was always intended as a replacement for the smaller, shorter-ranged, twin-engined Lockheed Ventura, and had been launched (as a private venture) in September 1941. This 'head start' was destined to have far-reaching effects. Unfortunately for Martin, Lockheed's Ventura replacement emerged as a much more capable aircraft than that for which the customer had asked. About one-third smaller than the Mercator, the Neptune was powered by Wright Cyclone engines with roughly the same output as the Mercator's primary reciprocating engines, yet was much lighter. It was able to carry a similar fuel load. As a result, the Neptune had a longer range than the four-engined Mercator, and had a significantly lower price tag. The Lockheed aircraft was also ready first and this would eventually prove to be critical.



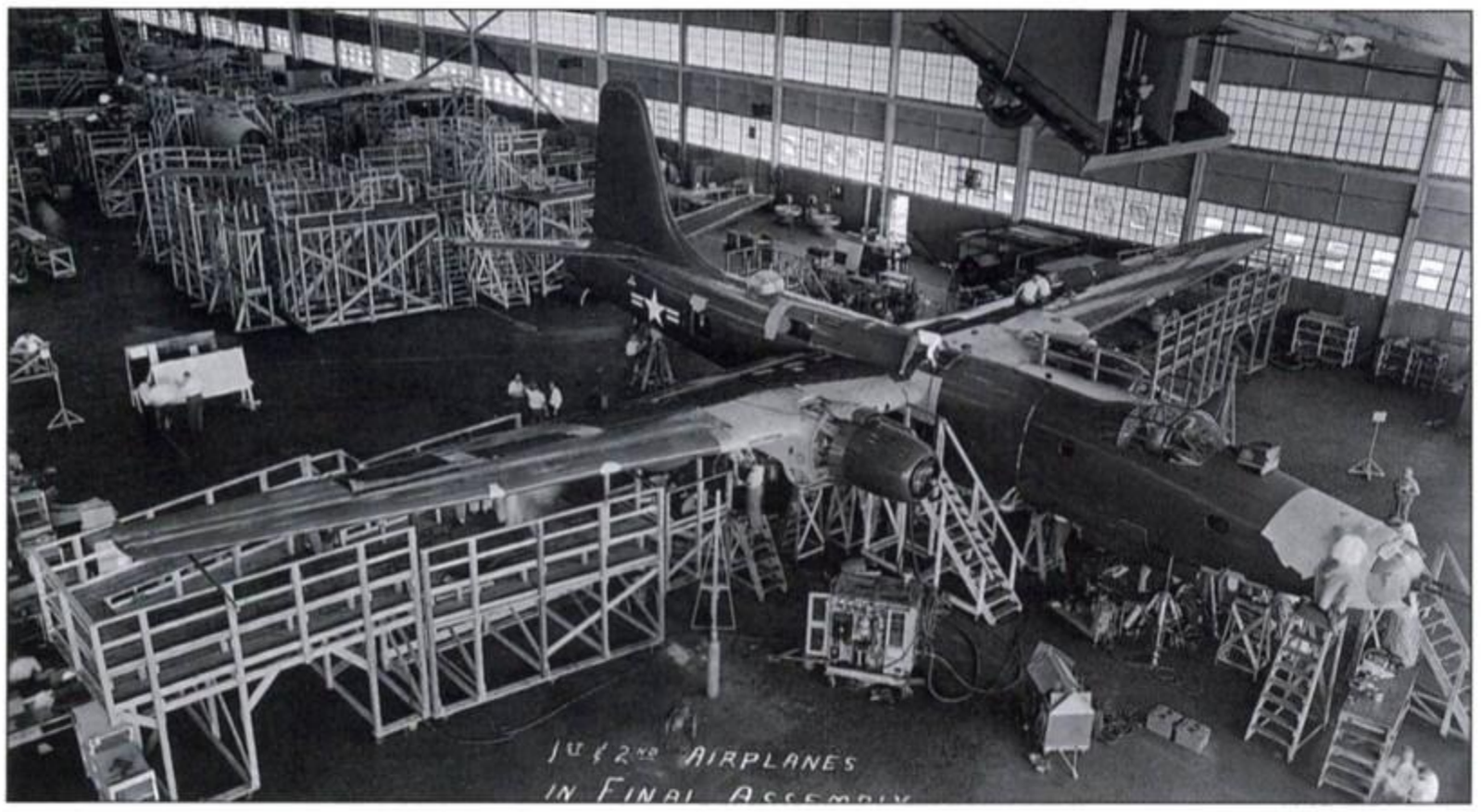
Neptune flies first

A contract for two XP2V-1 prototypes was issued on 4 February 1944, though Lockheed had previously received a letter of intent on 19 February 1943. Martin did not receive a contract until 6 July 1944. The first XP2V-1 prototype made the Neptune's maiden flight on 17 May 1945, its small size, simplicity and long pre-contract gestation allowing rapid progress. By contrast, the larger and more sophisticated Mercator did not fly until 20 September 1946, in the hands of Martin's chief test pilot and director of flight operations, O. E. 'Pat' Tibbs. This was a full two months after the two XP2Vs were delivered to the Navy, and only three weeks before the maiden flight of the production P2V-1.

When the first XP4M-1 (BuNo. 02789) was rolled out on 17 June 1946, it featured a Martin 250CE-324 mid-upper (deck) turret housing a pair of 0.50-in machine-guns, and a Martin X-220CH-2 tail turret with two T-31 20-mm cannon. The prototype also featured a 0.50-in waist gun on each side, though these were never used by in-service Mercators. The waist guns were each provided with 300 rounds, as were each of the 20-mm cannon in the tail, while the deck turret had 400 rounds per gun. The planned Emerson X250SE-2 nose turret was unarmed, since the aircraft was to have nose-mounted test instrumentation booms. In production aircraft, however, the Emerson turret had 20-mm cannon, which could traverse through an astonishing 180° in elevation, and 180° in azimuth.

The aircraft also featured a long, broad, flat, UK-style bomb bay, which marked a real break with traditional US practice, in which bombs tended to be stacked one above the other in short deep bays. The Mercator bomb bay could accommodate up to four fuel tanks in tandem, with a weight of 9,676 lb (4390 kg), or up to 12 610-lb depth bombs or 1,000-lb AN/M26-1 or Mk 13 mines in four rows, three-abreast. Alternatively, the aircraft could carry six 2,000-lb Mk 25 mines or a fuel tank and two Mk 13-3 torpedoes. The bomb bay configuration meant that weapons could be dropped in any order, or could all be dropped in a single pass, if necessary.

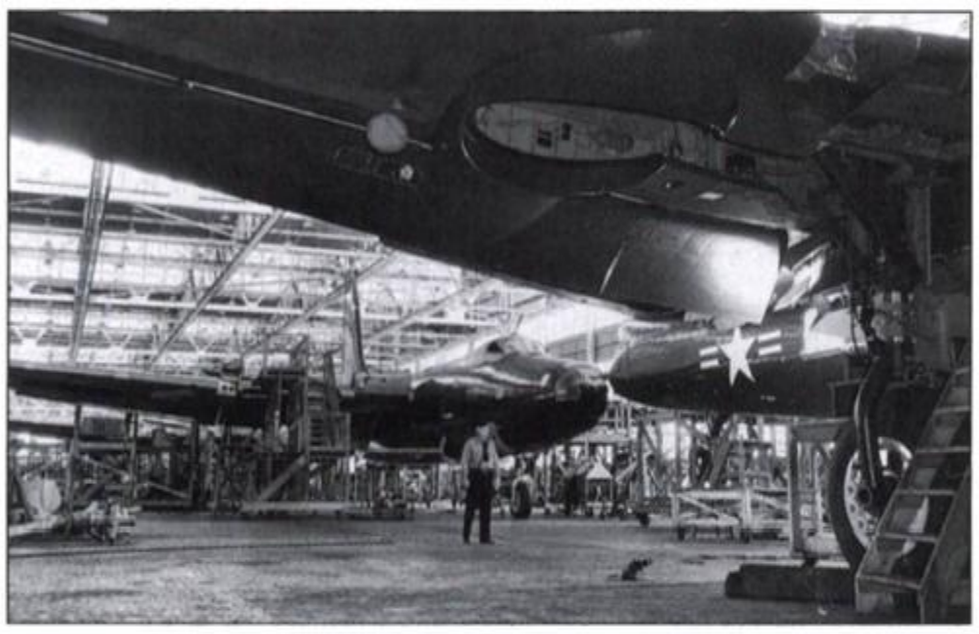
Minor glitches are inevitable during the early stages of an aircraft's flight test programme, and the Mercator's early problems should be seen in this light. The 2,000 psi hydraulics system was

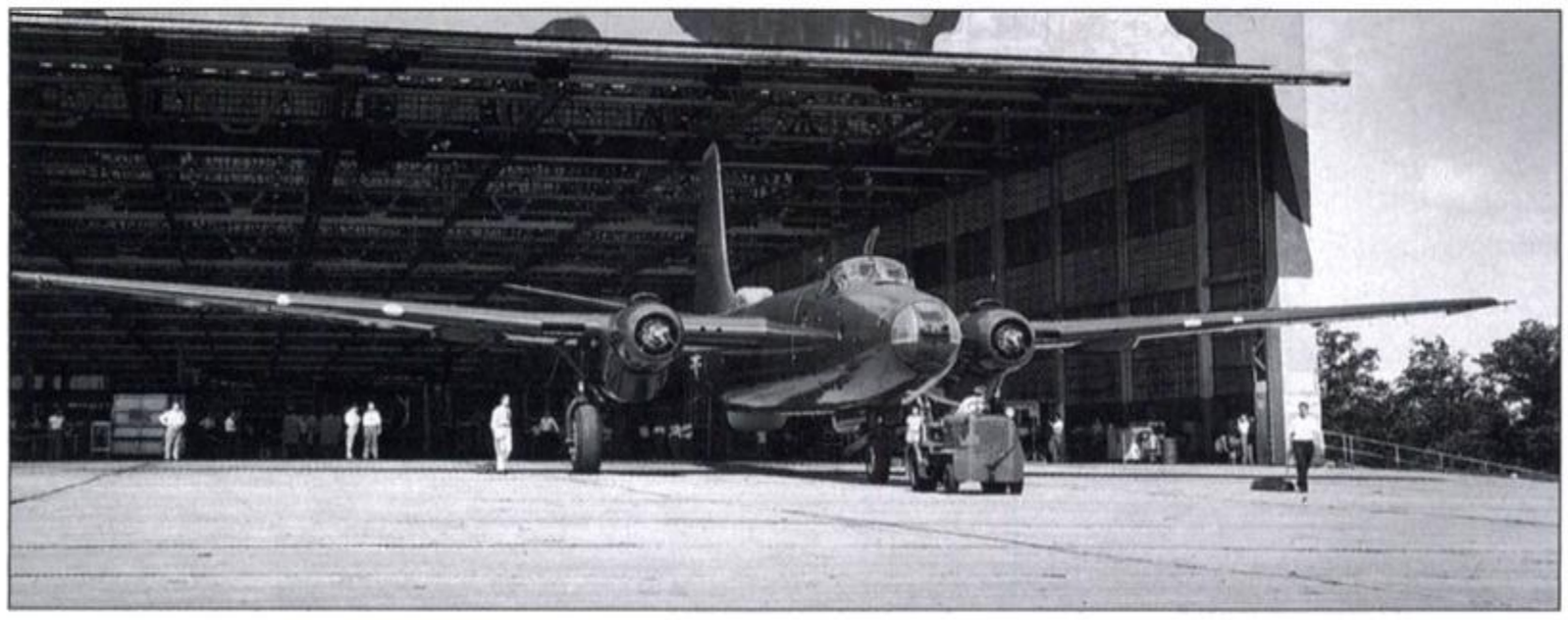


Above: The first production P4M-1 (BuNo. 121451) nears completion in 'D' building at the Martin factory, while others take shape nearby. The Mercator's span and the location of the mainplane almost midway along the fuselage are evident.

Right: Another view of the Mercator production line, shows BuNo. 124366 in the immediate foreground. At this stage of assembly, the aircraft are sitting on their undercarriage, but await engine fitting.

Below: An almost complete BuNo. 121451 is rolled out of the camouflaged 'D' building, though it has yet to have propellers fitted.





insufficient for the job, and on production aircraft the hydraulic system was uprated to 3,000 psi, which cured the problem. Undercarriage retraction was extremely slow, especially on the starboard side, where prop-wash tended to further restrict the speed of retraction.

The aircraft used 100-octane fuel for its piston and jet engines, and on one occasion a fuel line ruptured and flooded the countermeasures compartment. Two of the flight test engineers were overcome by fumes, one becoming submerged in the fuel. The other was revived on landing.

The second XP4M-1 Mercator prototype (BuNo. 02790) was built to a slightly different design, at the suggestion of Martin's Vice President of engineering, William K. Ebel. Ebel proposed offering an alternative, lighter weight, lower-drag Mercator, with its radar mounted in the nosecone, and with defensive armament restricted to the tail turret. The second Mercator made its maiden flight in this configuration. Both prototypes were originally fitted with four-bladed propellers, and both went on to test three-bladed airscrews. In the end, the four-bladed propellers proved preferable and were adopted for the production aircraft. The second prototype had a very brief career before being retired in July 1948. The airframe was subsequently stripped and used for drop-testing in 1950.

Martin subsequently modified the first prototype to resemble more closely the planned production configuration, with a lengthened forward fuselage, various dummy radomes and an enlarged tail fin. This restored the fin shape and size to that of the original mock-up, which had also featured a longer nose. The aircraft first flew in its new configuration in early 1948. Even then, the XP4M-1 did not look quite the same as the definitive production P4M-1, which also featured a stretched rear fuselage of longer and narrower profile. The bulky Martin X-220CH-2 tail turret was replaced by a smaller, lighter Emerson Aero 11B ball-type turret, containing two 20-mm cannon and 400 rounds of ammunition per gun. The provision of 20-mm cannon in the nose and tail promised to end the situation in which cannon-armed fighters could stand off, outside machine-gun range, 'pooping off' with their cannon. Now, the Mercator's defensive armament had the same range as the weapons likely to be used against it.

Mercator programme survives

With the tried-and-tested P2V Neptun almost ready for service, it was perhap remarkable that the Mercator programme continued at all, though the early results from the XP4M-1 flight trials were very promising, offering a significant performance advantage over the Neptune, including a service ceiling of 34,600 ft (10546 m). The aircraft also proved to have surprisingly pleasant handling characteristics, and long-serving company pilots realised that the Mercator was a very much better aircraft than its forebear, the Martin Marauder, whose deadly handling faults had led to a number of unflattering epithets, including 'The Flying Coffin', the 'Widow-maker' and, more colourfully, 'The Baltimore Whore'. The criticism was always overblown and the Marauder served well in combat, but at MacDill Army Air Base in Tampa, Florida, losses in training were so heavy that crews joked about crashing 'one day in Tampa Bay'.

If the survival of the programme was surprising, then the subsequent order for 19 production P4M-1s (only 51 Neptunes were then on order) was little short of miraculous. It did not seem to be the result of any great effort on Martin's part. Even as XP4M-1 flight trials continued, the Glenn Martin Company afforded the programme a low priority, preferring to concentrate on its Model 2-0-2, 3-0-3 and 4-0-4 airliners, the XBTM-1 Mauler, the XP5M Marlin flying-boat, and various experiments relating to missile control and guidance, and to the XB-48 and XB-51 bombers. The latter included trials of the XB-26H, a Martin Marauder fitted with a bicycle landing gear and known affectionately as the 'Middle River Stump Jumper.'

The manufacturer rolled out the first production P4M-1 (BuNo. 121451) on 18 July 1949, initially flying it with a dummy, non-transparent deck turret. Development flying was generally smooth, though the second aircraft (BuNo. 121452) inadvertently landed wheels-up on 8 February 1950. On 2 March 1950 BuNo. 121454 landed very heavily in gusty conditions, with the starboard engine separating from the firewall. Both aircraft were repaired, although BuNo. 121452 was lost in a fatal accident on 8 March 1951, spinning into the sea after a suspected engine problem.

The production P4M-1 was operated by a crew of nine, consisting of two pilots, a navigator (in the nose, at a port-facing chart table), radio and radar operators facing forward (right and left) behind and below the flight deck, an RCM operator facing to starboard just

In this January 1950 view the fifth production aircraft (BuNo. 122207) appears to be flying with 'two turning and two burning' as the engine nacelle intake shutters for the Allison J33-A-10A turbojets are in the open position. The larger of the two radomes under the fuselage housed the main search radar – an AN/APR-33 set. Note also that the outer wing did not have sufficient thickness to house the retracted landing gear.

Lower right: The fourth production P4M-1 (foreground) plus the third and first machines sit on the Martin flightline prior to delivery. The radome under the forward fuselage was attached to the bomb bay door; note its position when these doors were opened.

ahead of the main spar, a camera operator in the rear fuselage and two dedicated gunners (in the nose and tail, leaving the deck turret to the camera operator). Four of the crew were usually officers, the rest being enlisted men.

With greater application, Martin might have completed development of the Mercator more quickly, and the type might have been ready for service earlier. By the time the 19th and last P4M-1 rolled off the line in September 1950, the cheaper Neptune had built an unassailable primacy, equipping 13 squadrons, and there seemed little logic in having two long-range patrol types in the inventory, so 15 more units re-equipped with the Lockheed aircraft.

In the meantime, from 28 June 1950, VP-21 at NAS Patuxent River began trading its PB4Y-2 Privateers for new P4M-1s. The squadron received its first Mercator on that date, soon followed by four more in August, to bring its strength to the intended nine aircraft. The squadron was promptly scheduled to deploy to Port Lyautey, French Morocco, to operate in the long-range mine-laying role during an extended five-month Mediterranean deployment. The Mercator's AN/APS-33 radar was modified for greater accuracy in mine-laying operations.

Before it could ship overseas, the squadron had to solve some problems, as remembered by Ensign (later Rear Admiral) Isham W. 'Sam' Linder. "There was a feeling that the squadron could not operate effectively away from its support base at Pax [Patuxent River, Maryland]. We had a lot of aircraft maintenance problems. In particular, the jet engine had apparently had blade failures in other applications in the Navy, so their use was restricted on the P4M. They were started and kept on idle for take-offs and landings (emergency use only) and the squadron had to do all of its flying with recips only." In addition, the squadron technicians were busy with other problems which could be associated with the arrival of a new aircraft, such as hydraulic and electrical problems that had to be sorted out.

Linder remembers that a new commander who took over VP-21 in 1951 "...tackled this morale problem. He persuaded AIRLANT to let the squadron fly around the country as a single unit. So in the summer of 1951 we took off for what was about a week-long series of flights. On all legs of the exercise we flew either as a single unit or as three-plane sections. The first day was Pax to Pensacola. The second leg was from Pensacola to San Diego, North Island. On that trip we took publicity photos of aircraft flying low over the Grand Canyon, something that would cause all sorts of outcry today." Linder describes similar flying to Seattle, then back over the western US and back to Patuxent, pointing out that the trip was "...a success in demonstrating that the aircraft could be maintained and operated away from home."

In early days Stateside and at Port Lyautey, VP-21 also had to cope with a succession of nosegear failures and engine fires, but did not lose any aircraft. The squadron was initially thought to be unable to operate away from its maintenance facilities, although a series of very long-range demonstrations (including a 21-hour 50-minute endurance test, and the Mediterranean jaunt) helped to iron out the bugs, and also improved the aircrews' morale. Later in the Mercator's career, the jet engines were routinely employed, without restrictions or problems.

The Mercator's problems were relatively minor compared to those suffered by Lockheed P2V-4s and -5s in use in other front-line US Navy squadrons, which suffered serious faults in their primary engines. This led to VP-21 receiving a secondary VIP transport commitment, for which the Mercator's high speed and generous headroom made it well-suited.

Reconnaissance mission

However successful the P4M-1 was in service, it made little sense to have a single patrol squadron operating Mercators, while the rest of the patrol community operated Neptunes. For a while there seemed to be a possibility that the aircraft would be switched to the high-speed transport role, or sold to an ally. While no one in the higher echelons of the patrol community really knew what to do with the Mercator, the lumbering Privateer was showing increasing vulnerability in the electronic and radar reconnaissance roles. The 18 surviving Mercators (nine still serving with VP-21) had obvious potential as PB4Y replacements. Diverting Neptunes as Privateer replacements made no sense at all, since they were too small, too slow and too limited even before the addition of heavy electronic equipment and extra crew stations.

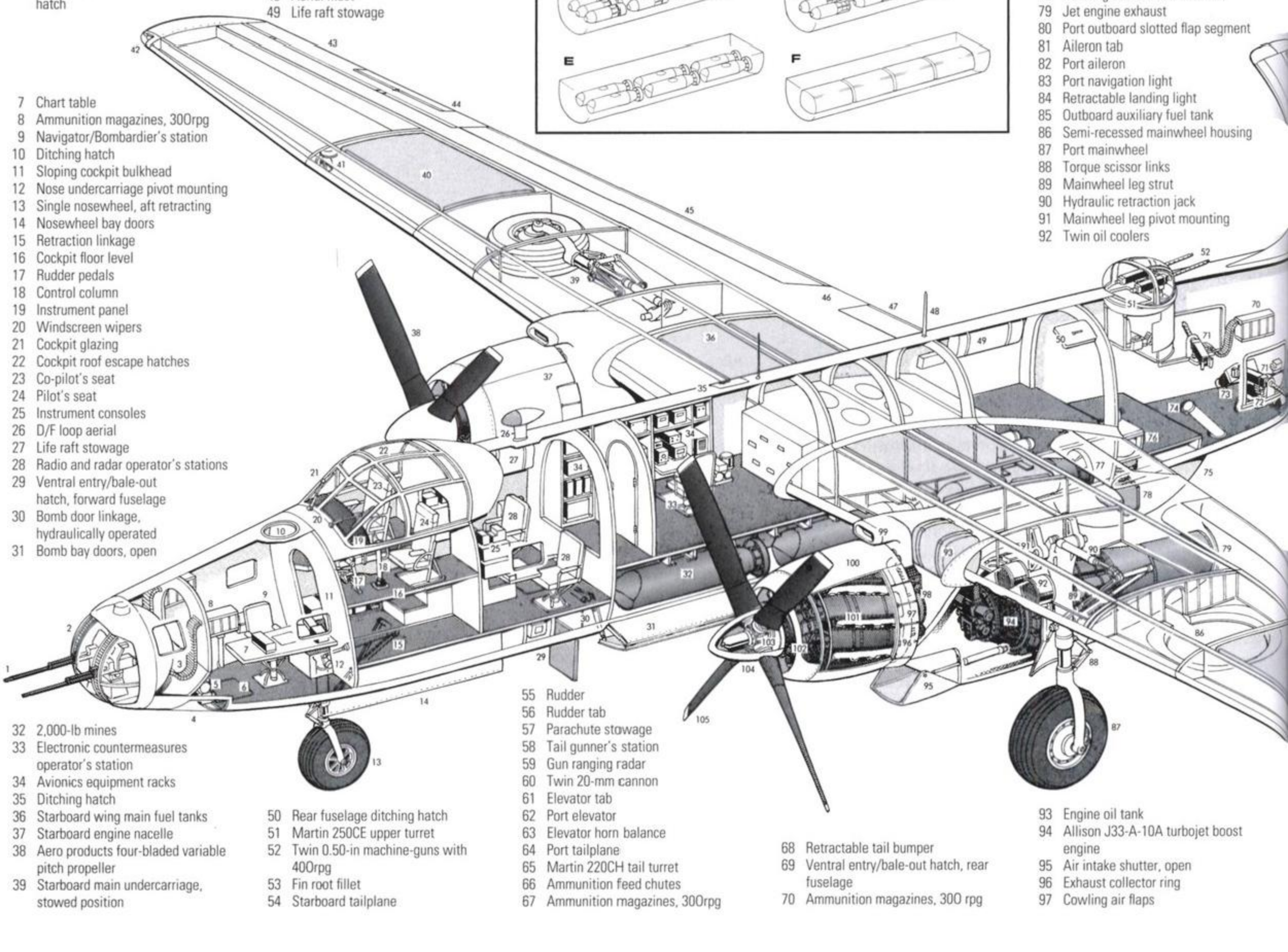
The only front-line Mercator unit, VP-21, had operated 10 P4M-1s (BuNos 122208, 122209, 124362, 124363, 124364, 124365, 124366, 124367, 124368 and 124373), nine at any one time. Even while these aircraft remained in service, from 1950 the Navy began converting the remainder of the production run to P4M-1Q configuration (for the detection, interception and analysis of enemy radar transmissions). The newly-assigned P4M-1Q designation reflected an electronic function. Later, even the VP-21 Mercators were converted to P4M-1Q configuration, 18 P4M-1Qs eventually entering service.

The conversion work was conducted at the Overhaul and Repair Facility at NAS Norfolk, where the prototype conversion (believed to have been BuNo. 121451, the first production P4M-1) made its maiden flight in February 1951.

Navy personnel inspect one of their new charges, BuNo. 122209, the third Mercator delivered to VP-21 (and appropriately coded '3'). Later converted to P4M-1Q standard, 122209 went on to serve with Det A VW-2, VQ-2 and VQ-1. It was this aircraft that was fired upon by North Korean fighters on 16 June 1959.

The P4M-1Q had the same basic flight crew as the P4M (pilot, co-pilot, navigator, radar operator and radio operator) but also carried a plane captain, and three rather than two dedicated gunners. On the other hand, the RCM operator's position ahead of the wing spar, and the camera operator's position in the rear fuselage, were deleted. The RCM operator's compartment was replaced by equipment racks and a station for the plane captain, while five operators' stations (facing to starboard) and a supervising evaluator's station (facing forward) were added in the rear fuselage. The supervising evaluator or Electronics Officer and the four operators were drawn from a separate unit, US Comm Unit 32G, and were separately

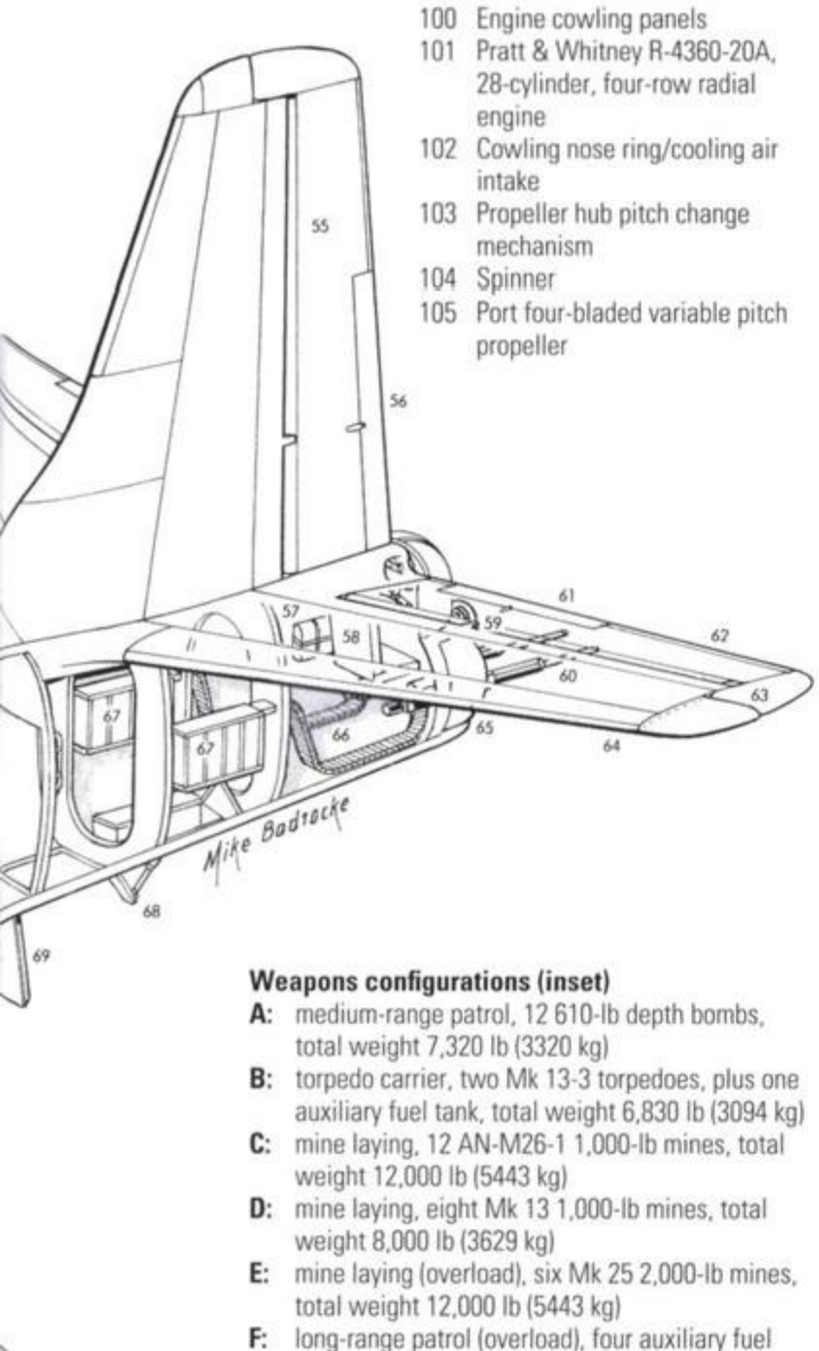
P4M-1 Mercator



1 Twin 20-mm cannon
2 Emerson nose turret
3 Ammunition feed chutes
4 Ventral window
5 Bomb sight
6 Navigator/bombardier's bale-out hatch
7 Chart table
8 Ammunition magazines, 300rpg
9 Navigator/Bombardier's station
10 Ditching hatch
11 Sloping cockpit bulkhead
12 Nose undercarriage pivot mounting
13 Single nosewheel, aft retracting
14 Nosewheel bay doors
15 Retraction linkage
16 Cockpit floor level
17 Rudder pedals
18 Control column
19 Instrument panel
20 Windscreen wipers
21 Cockpit glazing
22 Cockpit roof escape hatches
23 Co-pilot's seat
24 Pilot's seat
25 Instrument consoles
26 D/F loop aerial
27 Life raft stowage
28 Radio and radar operator's stations
29 Ventral entry/bale-out hatch, forward fuselage
30 Bomb door linkage, hydraulically operated
31 Bomb bay doors, open
32 2,000-lb mines
33 Electronic countermeasures operator's station
34 Avionics equipment racks
35 Ditching hatch
36 Starboard wing main fuel tanks
37 Starboard engine nacelle
38 Aero products four-bladed variable pitch propeller
39 Starboard main undercarriage, stowed position
40 Outboard auxiliary fuel tank
41 Retractable landing light
42 Starboard navigation light
43 Starboard aileron
44 Aileron tab
45 Outboard slotted flap segment
46 Fixed portion of trailing edge
47 Inboard slotted flap segment
48 Aerial mast
49 Life raft stowage
50 Rear fuselage ditching hatch
51 Martin 250CE upper turret
52 Twin 0.50-in machine-guns with 400rpg
53 Fin root fillet
54 Starboard tailplane
55 Rudder
56 Rudder tab
57 Parachute stowage
58 Tail gunner's station
59 Gun ranging radar
60 Twin 20-mm cannon
61 Elevator tab
62 Port elevator
63 Elevator horn balance
64 Port tailplane
65 Martin 220CH tail turret
66 Ammunition feed chutes
67 Ammunition magazines, 300rpg
68 Retractable tail bumper
69 Ventral entry/bale-out hatch, rear fuselage
70 Ammunition magazines, 300 rpg
71 0.50-in machine guns, port and starboard
72 Waist gun flexible mountings
73 Reconnaisance cameras
74 Sonobuoy chute
75 Ventral radome
76 Crew toilet
77 Port inboard flap segment
78 Rotating search radar scanner
79 Jet engine exhaust
80 Port outboard slotted flap segment
81 Aileron tab
82 Port aileron
83 Port navigation light
84 Retractable landing light
85 Outboard auxiliary fuel tank
86 Semi-recessed mainwheel housing
87 Port mainwheel
88 Torque scissor links
89 Mainwheel leg strut
90 Hydraulic retraction jack
91 Mainwheel leg pivot mounting
92 Twin oil coolers
93 Engine oil tank
94 Allison J33-A-10A turbojet boost engine
95 Air intake shutter, open
96 Exhaust collector ring
97 Cowling air flaps

Inset: In a hangar at NAS Patuxent River, VP-21 personnel perform a 30-hour check on one of a Mercator's two P&W R-4360 Wasp Majors. In the P4M these four-row, 28-cylinder powerplants were rated at 3,250 hp (2424 kW) for take-off.

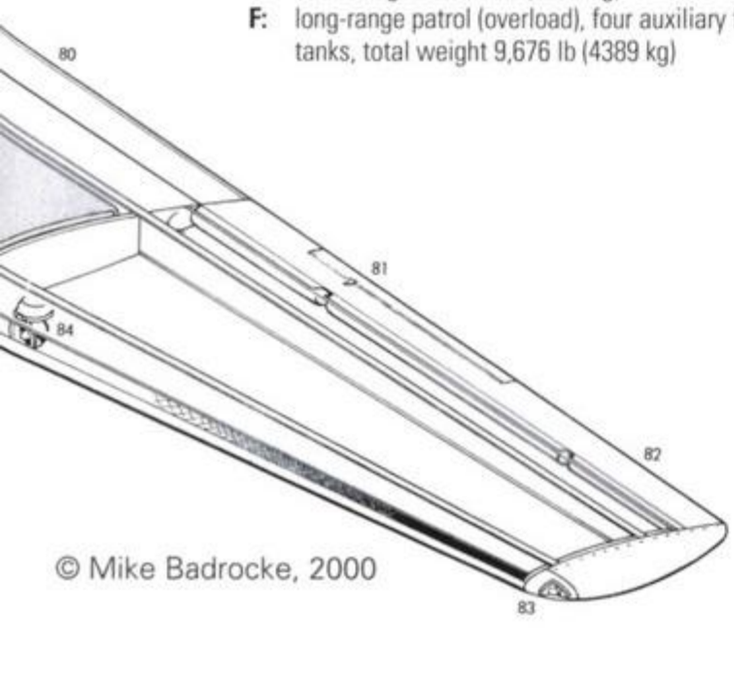
Main picture: Five of VP-21's P4M-1s are seen parked adjacent to the seaplane hangar at Patuxent River in October 1960.



98 Reciprocating engine accessory equipment
99 Carburettor air intake
100 Engine cowling panels
101 Pratt & Whitney R-4360-20A, 28-cylinder, four-row radial engine
102 Cowling nose ring/cooling air intake
103 Propeller hub pitch change mechanism
104 Spinner
105 Port four-bladed variable pitch propeller

Weapons configurations (inset)

A: medium-range patrol, 12 610-lb depth bombs, total weight 7,320 lb (3320 kg)
B: torpedo carrier, two Mk 13-3 torpedoes, plus one auxiliary fuel tank, total weight 6,830 lb (3094 kg)
C: mine laying, 12 AN-M26-1 1,000-lb mines, total weight 12,000 lb (5443 kg)
D: mine laying, eight Mk 13 1,000-lb mines, total weight 8,000 lb (3629 kg)
E: mine laying (overload), six Mk 25 2,000-lb mines, total weight 12,000 lb (5443 kg)
F: long-range patrol (overload), four auxiliary fuel tanks, total weight 9,676 lb (4389 kg)



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commanded, living in separate barracks and working from separate buildings on the ground. Discussions between Comm Unit 32G personnel and their flight crews was prohibited and personnel were warned that they would be monitored by the FBI for 10 years after their discharge! This new mission crew raised the basic crew complement from nine to 14, although the addition of new equipment later in the P4M-1Qs eventually brought the crew complement to 16.

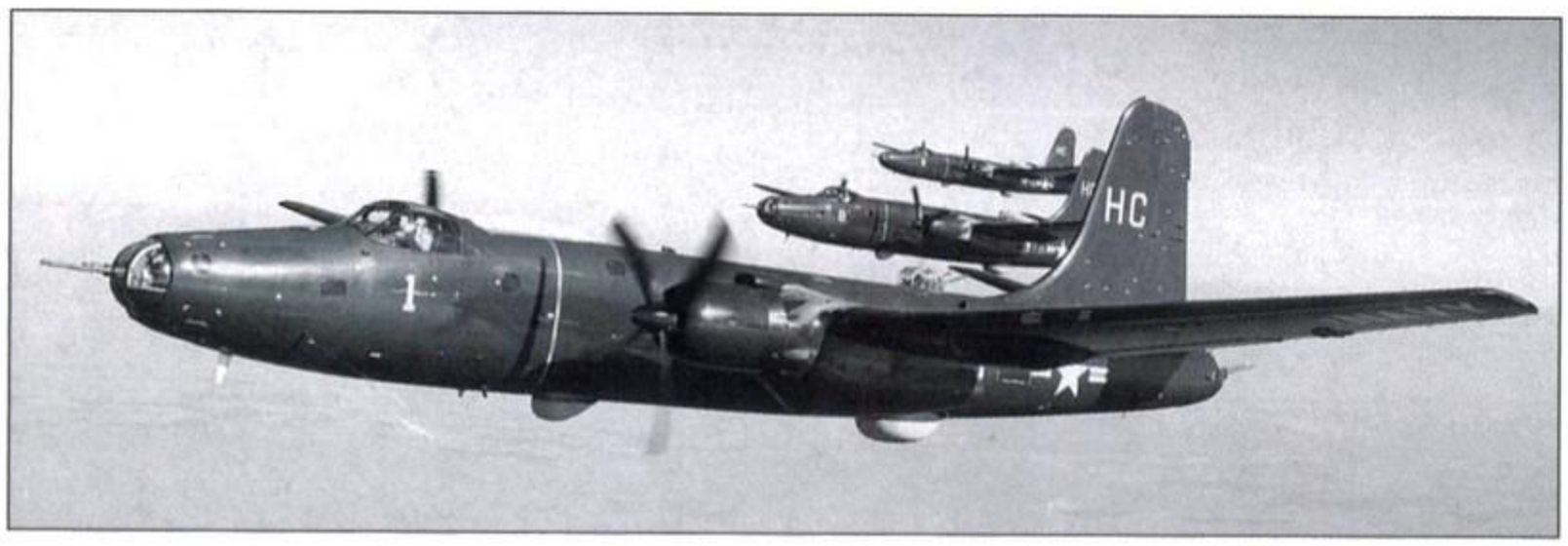
The aircraft was naturally fitted with a range of new receivers (four APR-4s and four APR-9s, each with its own tuning unit and panoramic adaptor), covering the frequency spectrum from 50-10,750 MHz. Their presence was indicated by an array of new antennas. Below the fuselage were AS436/APA-69, AS434/APA-69 and AS435/APA-69 antennas in blister-type radomes. These were respectively located under the extreme nose, under the forward part of the former weapons bay (offset to port) and about mid-way along the weapons bay (offset to starboard). There were also a host of blade, whip and wire antennas, and some flush antennas let into the skin. Each operator had a wire recorder and a direction finder, and could use one APR-4 and one APR-9. The evaluator had an SLA-1 pulse analyser which could be used to display the signals (video or audio) from any operator's station, and this was fitted with a solenoid operated camera which automatically photographed any new video signal pulse to allow later analysis, which was especially useful when a signal was of very short duration. The Mercator looked only at enemy radar transmissions and did not 'listen' to associated communications traffic, this being left to other platforms. The evaluator could talk to the pilot over the redesigned intercom, but the operators could not (though the pilot could break in when they were talking to each other or to the evaluator). Generally, the forward crew/gunners used a separate intercom system to that used by the 'mission crew'.

Heavier aircraft

The P4M-1Q Elint aircraft was a substantially heavier aircraft than the basic P4M-1 patrol version, and was actually heavier than the cleared maximum gross weight of the original P4M-1 model (which had been 82,500 lb/ 37422 kg). The solution was a hand-written alteration to the 'Dash One', raising the maximum gross weight to 92,500 lb (41958 kg), and an acceptance of the consequences. The increased weight naturally translated into reduced performance. At full weight, it has been suggested that the P4M-1Q's ceiling dropped to 16,900 ft (5151 m), though witnesses suggest that fully laden P4M-1Qs were operated at altitudes of 33,500 ft (10211 m), the thin air at these heights causing rectifiers aboard the aircraft to blow!

Whatever the ceiling, the heavy P4M-1Q did suffer from a reduced radius of action, and range fell from 2,840 to 2,000 miles (4570 to 3218 km). At 5,000 ft (1524 m), without the J33s, the P4M-1Q needed climb power just to maintain height. Fortunately, the P4M-1Q remained a very fast aircraft, cruising at 180 kt (333 km/h), but able to accelerate rapidly to more than 340 kt (630 km/h) if the J33s were brought on line. According to one former crewman, B. M. Bonney, "I have seen 380 knots on the 'straight and level' with 'two turning and two burning' and over 500 knots in a dive!" But while the Mercator was still fast, the extra weight associated with the P4M-1Q modification was not well distributed, most being added behind the centre of gravity, which became critical in some circumstances, especially when fuel in the forward bomb bay tanks was burned off.

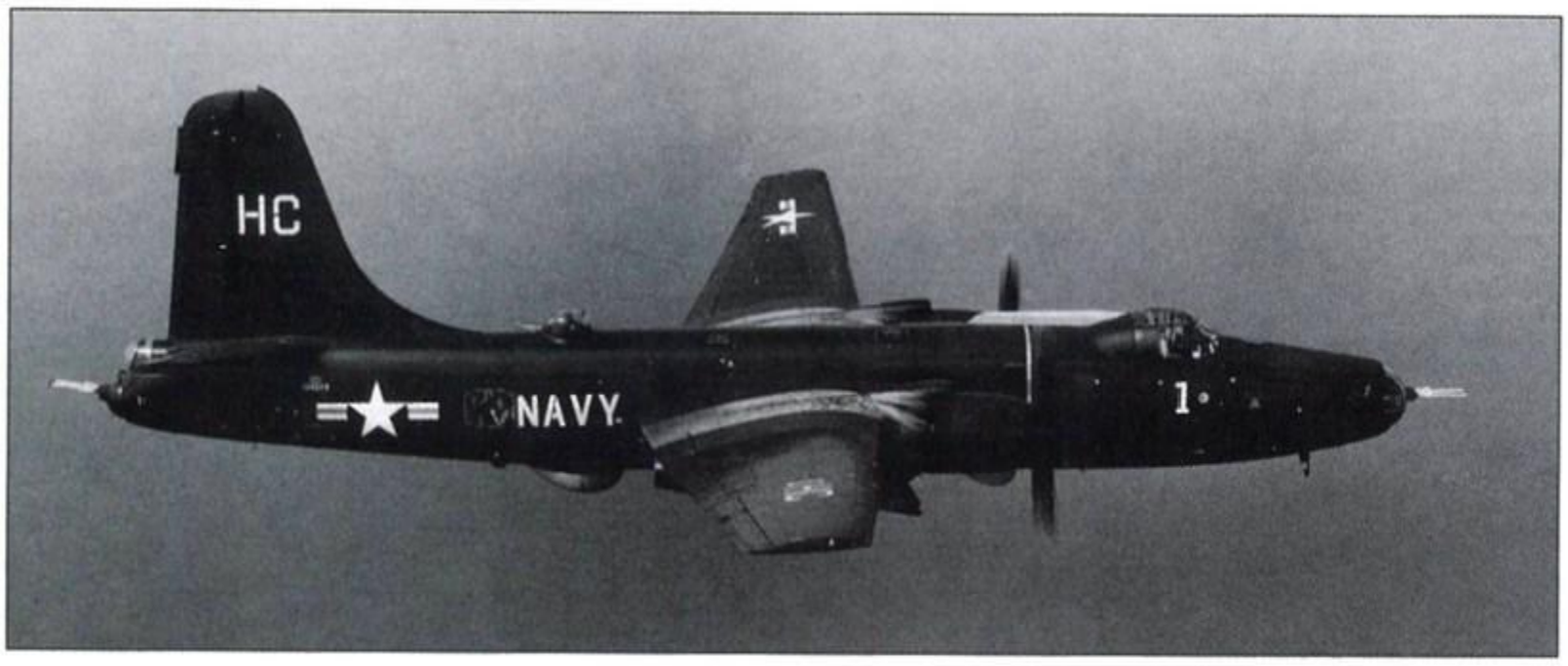
The Elint Mercator was destined to equip two squadrons – one assigned to the Atlantic Fleet and one to the Pacific – which would eventually operate under no fewer than nine designations. Their role was initially regarded as top-secret, and the newly formed units were assigned deliberately misleading designations. In the Atlantic Fleet, VP-26 had operated PB4Y-2 Privateers on highly dangerous border reconnaissance missions and shallow overflights of hostile territory or territorial waters. Following a PB4Y shoot-down over the Baltic (and the loss of another Privateer on take-off from Rome, after sabotage), the unit transferred to Port Lyautey, Morocco, forming the NAF Patrol Unit. Also known as the Patrol



Left: PATRON 21's first Mercator, BuNo. 122208, was to have been delivered in April 1950, but last minute modifications delayed this until June. here 'HC/1' is seen with 'HC/5' and 'HC/8'.

Lower left: BuNo. 124373 (by July 1951 coded 'HC/1') was the last production Mercator. Later converted to P4M-1Q standard, it crashed in 1958.

Bottom left: Three of VP-21s aircraft formate for an official photographer near San Diego in late July 1951. When VP-21 was selected to operate the Mercator it was equipped with PB4Y-2 Privateers, the squadron flying both types during the summer of 1950, the first P4Ms having been delivered in June and July.



Unit/NavComUnit 32G, this Privateer squadron received its first P4M-1Q in February or March 1951, although the first aircraft's back-end installation proved unsatisfactory. This unit received three more P4M-1Qs, with a refined internal configuration (designed by Lieutenant Robert L. Ashford, USNR), in June 1951. This revised configuration later formed the basis of the layout used in the WV-2Q, the EC-121M and the EA-3B Skywarrior.

Within the Pacific Fleet, four P4M-1Qs were assigned to VC-11 at NAS Miramar in April 1951 for aircrew training. The aircraft and aircrew moved to NAS Sangley Point in the Philippines in September 1951, where the unit operated as Special Products Division, Air Operations Department.

Great secrecy surrounded the Mercator operations, which were conducted under extraordinary rules and regulations. When, on 7 May 1952, one Port Lyautey-based Mercator (BuNo. 124371) lost an engine over mountainous terrain, the crew was not permitted to transmit a 'Mayday' until after the aircraft was safely clear of the operational area. The captain was forced to make extensive use of his two J33 engines to clear the mountains, and the aircraft was forced to ditch in the Mediterranean with fuel starvation, just north of Cyprus. The crew was recovered, apart from the pilot who drowned, although a Royal Navy Sea Otter from Nicosia, Cyprus, was lost with its pilot during the rescue operation.

The innocuously named Mercator squadrons were soon redesignated as detachments of existing Early Warning Squadrons. The NAF Patrol Unit became Detachment Able of VW-2 in early 1953, while the Special Products Division, Air Operations Department became Detachment Able of VW-1 on 13 April 1953. The Pacific Fleet unit was redesignated as Detachment Able of VW-3 in June 1954. These designations were entirely fictitious, and the COs of the real VW-1/VW-3 and VW-2 knew nothing about their supposed detachments. This was illustrated dramatically in 1954, when VW-3's CO accosted a Mercator crew after he saw the markings on their aircraft. He demanded to know what they were doing, and reportedly became irate when the Mercator crew apologetically refused to tell him.

Bogus Bureau Numbers

The VW-3 CO was perhaps unlucky to see his unit's designation painted on a Mercator, since the aircraft routinely operated with only stars and bars and false Bureau Numbers. Navy titles and unit identifiers were usually omitted, but when they were applied they were almost inevitably bogus. The tailcodes selected usually belonged to Neptune squadrons operating in the area of interest, or were entirely spurious. The randomly selected bogus bureau numbers changed monthly until August 1956. Nor did the Mercators often use their assigned callsigns, more usually usurping those used by Neptune units.

Had that commander been told the truth, he might well have been even angrier. What was masquerading as his unit's 'Detachment Able' was, after all, routinely flying eight- or nine-hour spying missions (and occasional missions of up to 14 hours' duration) for the National Security Agency. The Mercators operated along the coasts of China, North Korea, the USSR and Vietnam, usually at night. Nights with too-bright moonlight were avoided, and when the aircraft did fly missions they did so without showing any lights. This was hardly respectable and far from the routine AEW missions flown by the real VW-3. At least the Mercators featured a galley behind the wing spar, and a toilet in the tail, facilities that made these very long-duration

Sometime in late 1950 or early 1951, one of VP-21's new Mercators arrives at Port Lyautey, Morocco to take up mine-laying duties from the French colony.

missions slightly more bearable for their crews.

While 'Detachment Able, VW-3' went about its nefarious business in the Pacific, 'Detachment Able, VW-2' did much the same in Europe. Nominally still based at Port Lyautey, the unit flew many of its operations from British bases and from Wiesbaden, flying into the Baltic and along the inner German border, usually using the bogus tailcodes 'YN', or later 'PS'. The aircraft were regular visitors to the US Navy's FASRON-200 at Hendon, and after October 1955, at Blackbushe, and also transited through Bovingdon on a number of occasions.

The operations of the two units were shrouded in secrecy, and not even those who were directly involved always knew the full story. The flight crews obviously knew where they were flying, and could guess at what they were doing, but the intercept operators (who were separately briefed and debriefed) were the only crew-members who knew at what they were looking. The operators were initially not even full members of the Mercator squadrons, being members of the Naval Communications Unit 38G (or 32C according to some reports), rotating through the units on temporary duty assignments.

Further redesignations resulted in the Mercator units being redesignated as Electronic Counter Measures Squadrons. 'Detachment Able, VW-3' became VQ-1 on 1 June 1955, while 'Detachment Able, VW-2' became VQ-2 on 1 September 1955. These redesignations were accompanied by an increase in unit establishment from four to six aircraft each, while the units began to make more use of their official tailcodes ('PR' for VQ-1 and 'JQ' for VQ-2), although bogus markings were still used when circumstances dictated. VQ-1, in particular, operated detachments of Mercators from Shemya, Alaska, that continued to wear the markings of the based P2V Neptune squadron, VP-9. VQ-1 moved to Iwakuni in October 1955, co-locating alongside a pair of Fairchild R4Q-1 Flying Boxcars, which used the same R-4360 engine as the Mercator. This was a significant move, and represented a real attempt to address the growing serviceability problems being experienced with the R-4360 and its Aero Products A-644FN propeller. These problems reflected the complexity of the engines, but also the fact that they had to be run at very high power settings (climb power) for a fully-laden P4M-1Q Mercator to even maintain altitude if the J33 jets were shut down.

It is July 1952 and one of VP-21's aircraft receives attention to one of its engines at Patuxent River. By this time PATRON 21 was converting to the P2V Neptune and the Mercator fleet was being prepared for P4M-1Q conversion.

At least one of the Mercator losses was the direct result of an engine failure, and several incidents nearly resulted in aircraft losses. On one occasion a distributor vibrated loose and rotated through 180°, causing the engine to misfire so badly that all the exhaust stacks and the carburettor inlet housing were literally blown off, though the offending powerplant did keep running. This was extremely fortunate, since the aircraft was said to have been over Haiphong, North Vietnam, when the incident occurred. On another mission over the Chinese coast, on 15 June 1955, BuNo. 124632 lost its port engine, which separated after a propeller malfunction. The aircraft went into a flat spin, but was recovered at 3,000 ft (914 m) through judicious use of the J33 engines. A similar incident occurred one year later, though this time the pilot managed to feather the prop before the engine could be ripped from its mountings.

At much the same time as the units became VQ-1 and VQ-2, the aircraft received the semi-matt, dark grey-blue colour scheme, in place of the original standard US Navy glossy midnight blue scheme used previously. Tailcodes, modexes and 'Navy' titles were generally removed, though they were reapplied after the August 1956 shoot-down of a VQ-1 P4M-1Q. Some aircraft flew with toned-down codes and titles, and even with the star in the national insignia toned down from white to grey-blue.

Four of the remaining Mercators were written off in service with the two Fleet ECM squadrons. Shortly after midnight on 22 August 1956, VQ-1's BuNo. 124362 (wearing the false serial 187642) was attacked by Chinese MiGs off the Chinese coast, near Shanghai. The aircraft was on a night radar intelligence mission. The pilot, Lieutenant Commander Milton Hutchinson transmitted a coded message ('Under attack by enemy aircraft'), repeating it once before the transmissions abruptly ceased. The Chinese later stated (via British diplomatic channels) that they had fired on what they believed was a Chinese Nationalist aircraft, spying or agent-dropping from Taiwan. A massive search

Mercator operators

Patrol Squadron 21 (VP-21)
VP-21 began trading its PB4Y-2 Privateers for P4M-1s on 28 June 1950. Between August 1951 and January 1952, the squadron made an extended deployment to the Mediterranean, returning to NAS Patuxent River to convert to the Neptune. Its P4M-1Qs went to NAS Norfolk for conversion to P4M-1Q configuration. Mercators used by VP-21 included 122208: HC/1, 122209: HC/3, 124362: HC/4, 124363: HC/2, 124364, 124365, 124366, 124367, 124368, and 124373: HC/1.

Composite Squadron 11 (VC-11)
Four Mercators were assigned to VC-11 at NAS Miramar in April 1951 for aircrew training. The aircraft and aircrew transferred to the so-called Special Products Division of the Air Operations Department at NAS Sangley Point in September 1951. VC-11's Mercators were 121451, 121453, 121454 and 124369.

Special Products Division of the Air Operations Department
The Special Products Division of the Air Operations Department (known colloquially simply as Special Projects) received four Mercators from VC-11 in September 1951, basing them at NAS Sangley Point in the Philippines. The unit was redesignated as Detachment Able, Airborne Early Warning Squadron One (VW-1) on 13 April 1953. The unit's Mercators were 121451, 121453, 121454 and 124369.

Detachment Able,
Airborne Early Warning Squadron One (VW-1)
Detachment Able, Airborne Early Warning Squadron One (VW-1) was formed from the Special Products Division of the Air Operations Department at Sangley Point on 13 April 1953. The redesignation was no more than cosmetic, and the new unit had no connection with the AEW unit. It was redesignated again, as Detachment Able, Airborne Early Warning Squadron Three (VW-3), in June 1954.

Detachment Able,
Airborne Early Warning Squadron Three (VW-3)
Detachment Able, Airborne Early Warning Squadron Three (VW-3) was formed in June 1954, by the simple expedient of renumbering VW-1's Detachment Able. It was in turn redesignated as Electronic Countermeasures Squadron One (VQ-1) on 1 June 1955.

Electronic Countermeasures Squadron One (VQ-1)
Electronic Countermeasures Squadron One (VQ-1) was formed on 1 June 1955 by redesignating Detachment Able of VW-3. After operating unmarked, its Mercators adopted 'PR' tailcodes from 1957, often with a bold lightning flash on the fin. When operating from Shemya, Alaska, the unit's aircraft also sometimes wore the tailcode 'PD', the latter actually belonging to VP-9, the Shemya-based Neptune squadron. Electronic Countermeasures Squadron One was in turn renamed as Fleet Air Reconnaissance Squadron One (still VQ-1) on 1 January 1960. VQ-1's Mercators included 122209: PR/9, 124363: PR/3, 124364: PR/4, 124366: PR/6, and 124368: PR/8 and PD/16.

Fleet Air Reconnaissance Squadron One (VQ-1)
The renamed Electronic Countermeasures Squadron One formed on 1 January 1960, at NAS Atsugi, as FAIRECONRON ONE. The squadron ceremonially retired its last two Mercators on 23 July 1960, though they had been formally struck on 30 June. FAIRECONRON ONE's Mercators were 124363: PR/3, 124364: PR/4, 124366: PR/6, and 124368: PR/8.

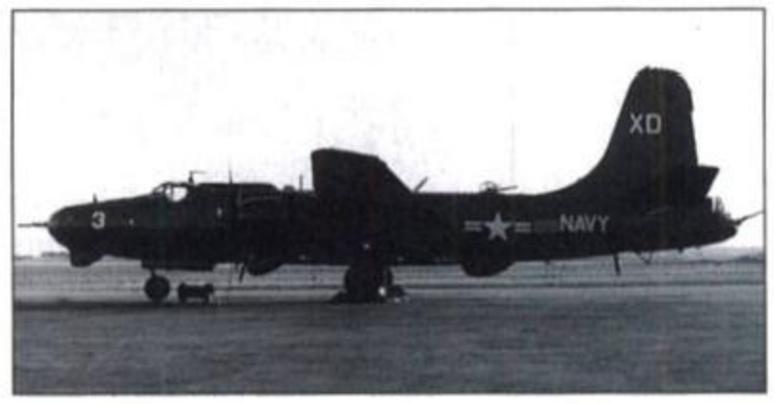
NAF Patrol Unit, Port Lyautey
The NAF Patrol Unit, Port Lyautey formed from the remnants of VP-26 when it transferred from West Germany, from where it had been flying dangerous reconnaissance and surveillance missions over the Baltic Sea. Re-equipping with Mercators in April 1951, the unit (also known as Patrol Unit/NavComUnit 32G) continued its highly classified missions, its aircraft usually flying unmarked, or with spurious 'YN' tailcodes meant to deceive enemy intelligence. The unit was redesignated as Detachment Able, Airborne Early Warning Squadron Two (VW-2) in early 1953. Mercators operated by NAFPU included 122208, 124370, 124371 and 124372.

Detachment Able,
Airborne Early Warning Squadron Two (VW-2)
Formed, in early 1953, by redesignating the NAF Patrol Unit, Port Lyautey, Detachment Able had no link with the 'real' Airborne Early Warning Squadron Two. Its aircraft often operated entirely unmarked (or with only 'star and bar' national insignia) but also used spurious markings, including 'XD' (during 1953-1954) and later 'PS'. The 'XD' code actually belonged to VX-6, the Antarctic squadron. The unit was redesignated as Electronic Countermeasures Squadron Two (VQ-2) on 1 September 1955. Aircraft used by the unit included 124370 XD/2 (in April 1953), 124372: XD/- (in October 1953), and 124373: XD/3 (in July 1954).

Electronic Countermeasures Squadron Two (VQ-2)
VQ-2 formed by the redesignation of Detachment Able, Airborne Early Warning Squadron Two (VW-2) on 1 September 1955. Its aircraft initially flew mainly with the tailcode 'PS', which had originated as one of a number of spurious markings applied to the Mercators of Det A, VW-2. The squadron began using its own 'JQ' tailcodes in 1957, later adding a squadron badge on the forward fuselage and a yellow band across the fin, on which were superimposed three black bats. VQ-2 was retitled as Fleet Air Reconnaissance Squadron Two on 1 January 1960, but retained its VQ-2 designation. VQ-2's Mercators included 122207: JQ/4, 122209: PS/2, 124365: JQ/6, and 124373: PS/3.

Fleet Air Reconnaissance Squadron Two (VQ-2)
Fleet Air Reconnaissance Squadron Two was formed on 14 January 1960 by the renaming of Electronic Countermeasures Squadron Two (VQ-2). The squadron moved to Rota, Spain, but relinquished its last P4M-1Qs in April 1960.

Above: P4M-1s of PATRON 21 were based at NAS Patuxent River.



Above: Seen here on Malta in 1954 while with Det A VW-2, but sporting bogus 'XD' VX-6 tailcodes, P4M-1Q BuNo. 124373 was an early casualty, crashing at Ocean View, Virginia on 6 January 1958, with the loss of its four crew.

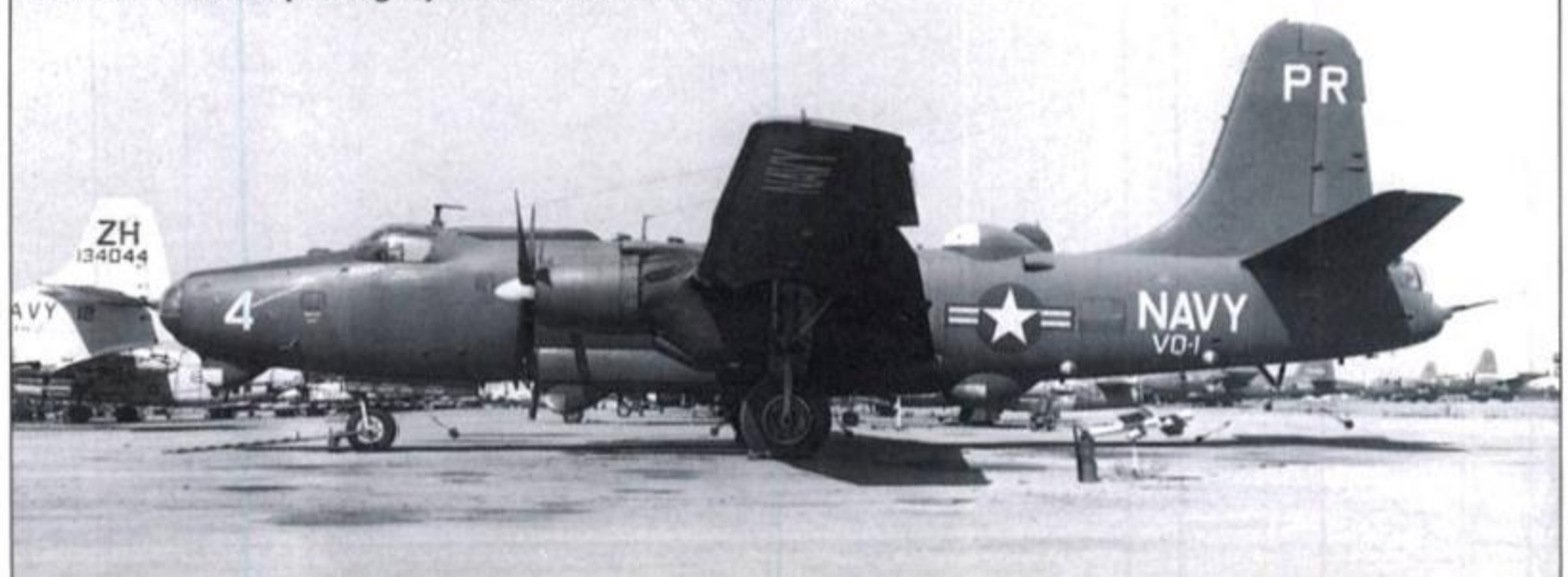
Above: When based at Misawa, BuNo. 122209 of VQ-1 was attacked by North Korean MiGs on 16 June 1959.

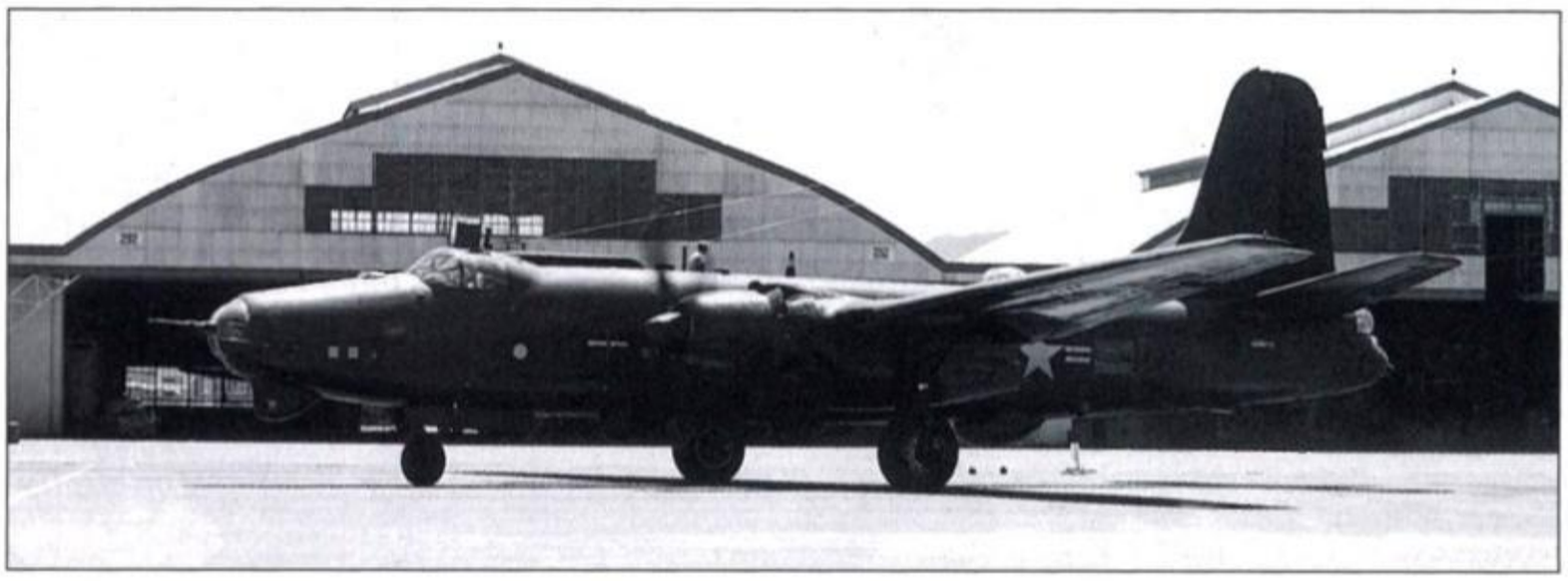
Above: BuNo. 124373 is seen in 1955, with 'PS' codes, as seen on Det A VW-2 and VQ-2 aircraft.

Above: This unidentified P4M-1Q is another 'PS' coded aircraft and was seen in the UK in 1955.

Below: BuNo. 124365 of VQ-2 has an ALD-1 direction finder fairing in place of its dorsal turret. It was photographed at Blackbushe on 14 September 1959.

BuNo. 124364, formerly of VQ-1, was the last Mercator to be scrapped on US soil and was photographed at NAS Alameda in 1960.





Above: The new chin radome and plated-over waist gunner's position indicate that this is a P4M-1Q – in fact the first Mercator to undergo conversion for Elint-gathering – BuNo. 121454. Note also that the NAVY legend usually applied to the rear fuselage has been painted over.

Right: One of VQ-1's P4M-1Qs taxies at NAS Iwakuni, Japan in August 1956. Note that it carries a bogus bureau number – '194873' – and no unit markings.

Lower right: Four unarmed Det A VW-2 P4M-1Qs share the ramp at NAF Port Lyautey in 1955. The 'PS' codes carried by the detachment's aircraft at this time were bogus (actually belonging to a PATRON); the following year 'JQ' codes were adopted, the unit having been redesignated VQ-2.

operation eventually recovered the bodies of two of the crew (two more eventually being found and returned by the Chinese), a mainwheel and tyre, two empty liferafts and two bomb-bay fuel tanks; the remainder of the crew were posted MIA.

The incident was naturally shocking, though it followed the shoot-downs of four US Navy Neptunes near enemy coasts in November 1951 (a VP-6 aircraft near Vladivostok), January 1953 (VP-22, shot down by Chinese shore batteries near Swatou), September 1954 (VP-19, off Siberia) and June 1955 (VP-9, over the Bering Strait). More Neptunes came under attack during the same period without being downed.

Guns refitted

The shoot-down of the Mercator led to the P4M-1Qs being permanently refitted with their defensive cannon and machine-guns. Aircraft had often been seen with empty turrets during 1955 and early 1956, and there is today some doubt as to whether the downed aircraft was actually armed. Increasing weight of mission equipment had led to the deletion of guns and gunners in an attempt to recover some of the aircraft's performance, but it was clear that the loss of defensive firepower was not an acceptable trade-off. On 19 November 1957, BuNo. 124372 of VQ-2 suffered an unspecified incident which led to it being struck off charge on 27 July 1958. VQ-2 lost another aircraft (BuNo. 124373) which crashed at Ocean View, Virginia, on 6 January 1958, killing four crew-members.

The last total loss was of BuNo. 122209 of VQ-1, which was bounced by North Korean fighters on 16 June 1959. The aircraft was attacked while flying a morning ESM mission near Wonsan (home of the North Korean 2nd Air Division) at an altitude of 7,000 ft (2133 m). Lieutenant Commander Donald Mayer put the Mercator into a steep, high-speed dive in an attempt to escape. The two enemy MiG-17s made six firing passes, knocking out the Mercator's two starboard engines and the rudder, and severely wounding the crewman in the tail turret (not the crew's usual tail-gunner), who received 40 shrapnel wounds. By the time of this engagement, the surviving P4M-1Qs had lost their mid-upper gun turrets, which had been replaced by a huge radome housing an AN/ALD-1 direction finder antenna. This placed more onus on the tail and nose gunners, and made it more difficult to engage fighters attacking from abeam or from above the aircraft. Despite this, the Mercator's gunners fired back as the air-

Seen here in a somewhat undignified pose after a nose gear collapse at Atsugi in January 1958, 'PR/9' (BuNo. 122209) was the aircraft attacked by North Korean MiGs on 16 June the following year. The lightning bolt marking on the tailfin appeared on a number of VQ-1 aircraft during the late 1950s.

Above: Mercator pilot Dean B. North poses with his charge 'PR/6' at Iwakuni in about 1957. After the August 1956 incident near Shanghai the P4M-1Q fleet was finished in standard USN Insignia Blue, though this machine remains gray.

Left: Seaplane Gray was initially applied to the P4M-1Qs and markings other than the national insignia were omitted. Here a Det A VW-3 aircraft warms up on Iwakuni's flightline sometime around 1956.

Below: Attrition, a lack of spare parts and the arrival of more capable aircraft finally saw the type retired in 1960. A somewhat bedraggled BuNo. 124364 is seen at NAS Alameda, on display during an 'open house' in 1960.

craft skimmed along above the waves.

The North Korean fighters which bounced 122209 broke off their attacks. Subsequently, four USAF fighters based at Itazuke, Japan, were launched to cover the Mercator as it headed for Japan, and four South Korean fighters established a patrol over the Korean coast to intercept any attempts to finish off the P4M-1Q. The USAF fighters escorted the Mercator to Miho, Japan, where the aircraft crash-landed. It was probably then stripped for spares. Pilots Mayer and Lieutenant Commander Vince Anania were awarded the DFC, with the rest of the crew receiving Air Medals, and the wounded crewman a Purple Heart.

Why the two Korean MiGs opened fire remains a mystery. 'Listening in' to the North Korean GCI station and the pilots was a C-47 of the 6053rd Radio Flight, with its crew of 6929th Radio Squadron (Mobile) linguists.

"There was nothing remarkable about the Mercator's mission that day, nor about the Korean response – until they opened fire. The MiG pilots and their controller said the same things every day running the same intercepts against the same kind of targets. The Mercator was not within 12 miles of the Chinese coast, though it was getting close. We didn't actually realise they'd attacked the Mercator (from what they said) until we got back to base..." said one of the C-47 crew, many years later.

Fleet Air Reconnaissance

The two front-line Mercator units were eventually redesignated as Fleet Air Reconnaissance Squadrons, though their VQ-(ECM squadron) unit designator prefix was retained. VQ-1 became Fleet Air Reconnaissance Squadron One on 1 January 1960, with VQ-2 following as Fleet Air Reconnaissance Squadron Two on 14 January. The change in designation did not help the crew of VQ-2's BuNo. 124365, which crashed on 16 January 1960, while operating from Incirlik in Turkey. All 16 crew-members were killed. This was a crash and not the result of hostile action.

With a front-line fleet whose initial strength consisted of only 18 P4M-1Qs (BuNo. 121452 was written off at the NATC on 8 March 1951, before being converted or redelivered), even relatively low attrition rates soon threatened the viability of the Mercator, while spares support was a similarly vital element in P4M-1Q operations. The critical point was reached in late 1959, and the aircraft was finally judged to be unsupportable in early 1960. VQ-2 (recently transferred to Rota, Spain) retired its last two P4M-1Qs in April 1960, leaving the unit dependent on two WV-2Q Warning Stars, three P2V-5F Neptunes and five A3D-2Q Skywarriors. VQ-1 at Atsugi retired the last of its four remaining Mercators on 23 July 1960, by which time its complement also included two F9F-8T Cougars, four WV-2Q Warning Stars and nine A3D-2Q Skywarriors. Three of the aircraft (BuNos 124363, 124366 and 124368) were scrapped at Atsugi, while the other (BuNo. 124364) was flown to NAS Alameda, where it stood for a while amidst rows of retired Neptunes. It was the last surviving Mercator and had been ferried back to the USA rather than being simply scrapped *in situ* in Spain or Japan. It could and should have been saved for preservation, but instead was eventually scrapped. Not a single example of the P4M-1 or P4M-1Q was saved for posterity, and the type is now largely forgotten.

Jon Lake, with additional material from Robert F. Dorr

Mercator production

02789	**XP4M-1**, NATC
02790	**XP4M-1**, NATC
121451	**P4M-1**, converted **P4M-1Q** (first conversion), VC-11, Special Products Division. SOC 27/3/51, scrapped NAS Norfolk
121452	**P4M-1**, '452' NATC, crashed Chesapeake Bay 8/3/51
121453	**P4M-1**, converted **P4M-1Q**, VC-11, Special Products Division, Det A VW-1, Det A VW-3, VQ-1. SOC 13/11/56, scrapped NAF Litchfield
121454	**P4M-1**, converted **P4M-1Q**, VC-11, Special Products Division, Det A VW-1, Det A VW-3, VQ-1. SOC 13/11/56, scrapped NAF Litchfield
122207	**P4M-1**, '207' NATC, converted **P4M-1Q**, Det A VW-2, 'JQ/4' VQ-2. SOC 15/4/60, scrapped NAS Rota
122208	**P4M-1**, VP-21, converted **P4M-1Q**, 'YN' NAFPU, Det A VW-2, VQ-2. SOC 11/56, scrapped NAS Norfolk
122209	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-2, 'PS/2' VQ-2, 'PR/9' VQ-1. Badly damaged by North Korean fighters 16/6/59. Scrapped for spares
124362	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-1, Det A VW-3, VQ-1. Shot down by Chinese fighters 22/8/56 (operating as 187642)
124363	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-1, Det A VW-3, 'PR/3' VQ-1 (last operational Mercator). SOC 30/6/60, scrapped Atsugi
124364	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-1, Det A VW-3, 'PR/4' VQ-1. SOC 5/4/60, scrapped Alameda
124365	**P4M-1**, VP-21, Stored at Litchfield, converted **P4M-1Q**, VQ-1, 'JQ/6' VQ-2. Crashed during mission from Incirlik, 16/1/60
124366	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-1, Det A VW-3, 'PR/6' VQ-2. SOC 19/5/60, scrapped Atsugi
124367	**P4M-1**, VP-21, converted **P4M-1Q**, Det A VW-2, VQ-2. SOC 7/4/60, scrapped NAS Rota
124368	**P4M-1**, VP-21, Stored at Litchfield, converted **P4M-1Q**, 'PR/8' VQ-1 (also operated as 'PD/16' of 'VP-9'). SOC 30/6/60, scrapped Atsugi
124369	**P4M-1**, converted **P4M-1Q**, uncoded with NATC, VC-11, Det A VW-1, Det A VW-3. SOC 13/11/56, scrapped NAF Litchfield
124370	**P4M-1**, Converted **P4M-1Q**, 'YN' NAFPU, Det A VW-2 (in April 1953 also operated as 'XD/2' of 'VX-6'), VQ-2. SOC 2/10/56, scrapped NAS Norfolk
124371	**P4M-1**, Converted **P4M-1Q**, 'YN' NAFPU, Det A VW-2. Ditched 'eastern Mediterranean' 7/2/52
124372	**P4M-1**, Converted **P4M-1Q**, 'YN' NAFPU, Det A VW-2 (in October 1953 also operated as 'XD/-' of 'VX-6'), NATC, VQ-2. Suffered accident 19/11/56 and SOC 27/7/58
124373	**P4M-1**, 'HC/1' VP-21, Converted **P4M-1Q**, 'PS/3' Det A VW-2 (in July 1954 also operated as 'XD/3' of 'VX-6'). Crashed at Ocean View 6/1/58

Bogus BuNos used by P4M-1Qs have included 187642 (on 124362), 194873

Martin P4M-1Q Mercator Electronic Countermeasures Squadron Two (VQ-2) NAF Port Lyautey, Morocco 1959

Established at Port Lyautey, Morocco on 1 September 1955 from Det A, VW-2, Electronic Countermeasures Squadron Two (VQ-2) was renamed Fleet Air Reconnaissance Squadron Two (retaining the VQ-2 designator) on 1 January 1960. As well as P4M-1Qs (at least eight of which are known to have flown with the unit), the squadron also operated P2V-5F Neptunes and in 1956 it received its first A3D-1Q Skywarriors. WV-2Q Super Constellations arrived in 1959 and by 31 March 1960, VQ-2 had a mixed fleet consisting of five A3D-2Qs, three P2V-5Fs, two WV-2Qs, and just a pair of Mercators. These and the Neptunes were phased out shortly afterwards.

Colour scheme
BuNo. 124365 is shown as it appeared in late 1959, apparently still finished in Seaplane Gray, though by this stage instructions had been issued to repaint the remaining P4M-1Qs in Insignia Blue (so-called 'Midnight Blue'). Note the contrast between the overall colour scheme and the Insignia Blue national insignia. The yellow tail band is a squadron marking, incorporating three bats from VQ-2's emblem.

Combined wing aerofoils
The Mercator's 114-ft 1⅛-in (34.77-m) span wing consisted of an unusual combination of two differing aerofoil sections. The centre section (NACA 2417) offered high lift, while the outer wing sections (NACA 2412) were optimised for high speed. The down side to this compromise was that the aircraft had somewhat unpleasant and startling stall characteristics, as the outer section of the wing would stall first.

P4M-1Q conversion
Though the only obvious external differences between the two variants were the addition of two new APA-69 direction finder antenna housings (one under the nose and a second mid-way along the bomb bay door) and the addition or relocation of a number of smaller antennas, the interior of the aircraft was changed considerably in the P4M-1Q. The RCM operator's position in the forward fuselage was removed and five new RCM (later ECM) operators stations were provided in the rear fuselage, in place of the now redundant camera station. Equipment racks behind the cockpit were retained, but much of this gear was moved or deleted, providing space for new equipment specific to the ELINT mission. By 1959, surviving P4M-1Qs had been fitted with an AN/ALD-1 direction finder, the antenna for which was housed in a large fairing in place of the dorsal turret.

Defensive armament
Although the waist gunner positions were deleted, the P4M-1Q initially retained the Emerson Aero 9A nose, Martin 250CE-324 dorsal and Emerson Aero 11B tail turrets of its predecessor. During 1955 and 1956 the Elint Mercators frequently flew without their guns installed to save weight, but the events of 22 August 1956, when BuNo. 124362 was shot down, brought their reinstallation.

Powerplants
The Mercator was one of the few mixed piston/turbojet types to see service, other examples including the US Navy's AJ Savage and the RAF's Shackleton MR.Mk 3 Phase III. The tiny Allison J33 (originally a General Electric project directly descended fom the British Whittle W.2B design) was built in large numbers, notably powering most members of the Lockheed F-80/T-33 family, including the USN's carrier-capable T2V. In the Mercator, the J33-A-10s (rated at 4,650 lb/20.68 kN thrust) were intended to improve take-off and landing performance, while enhancing survivability. The engines were housed under the wing, to the rear of the engine nacelle. This necessitated positioning the main undercarriage outboard of the engines.

This is how izdeliye 250A was envisaged in Lavochkin's advanced development project documents, depicted carrying a pair of large AAMs.

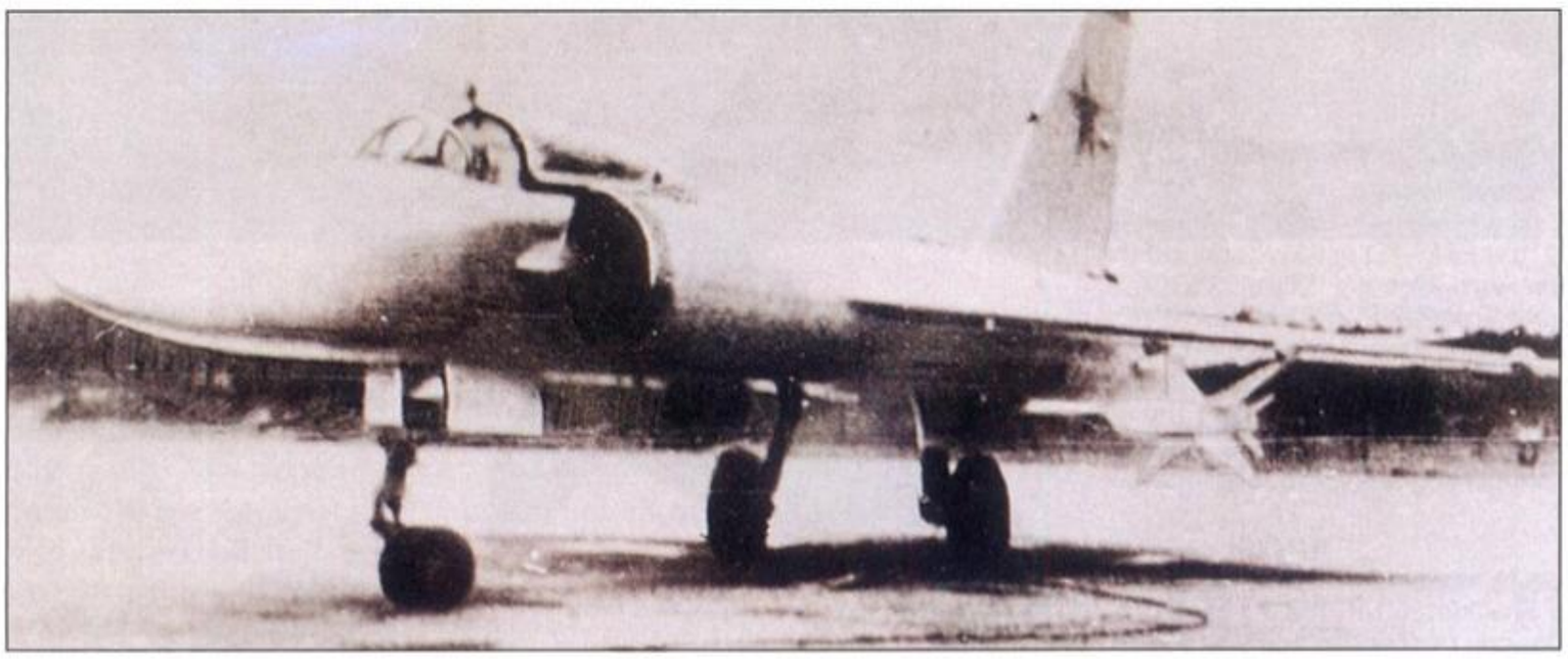
Beyond the Frontiers

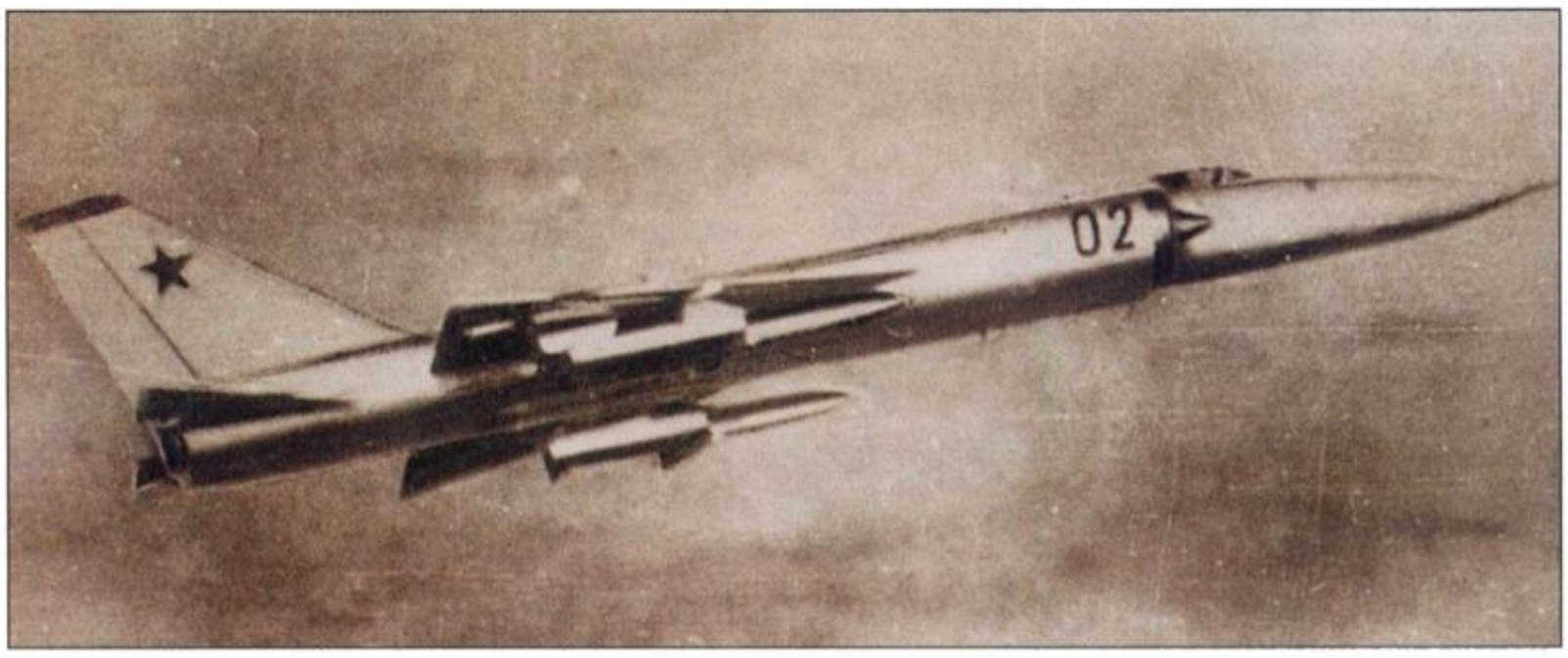
Lavochkin La-250 Anaconda

Lavochkin's response in the early 1950s to the pressing need for a missile armed interceptor, the *izdeliye* 250 gained it's unofficial Anaconda name on account of its sleek lines. Its early promise soon evaporated in an elongated programme fraught with accidents. Technical and design problems eventually lead to cancellation.

For years, the Soviet leaders could remain confident that the northern and eastern borders of the USSR were well guarded. They were guarded by nature itself; the vast expanses of water and ice made them inaccessible for would-be foes. Things changed dramatically in the late 1940s with the advent of strategic bombers possessing intercontinental range. Crossing the Arctic Ocean at high speed and altitude, they could strike at the Soviet Union's military and industrial centres. The Soviet Air Defence Force (PVO – Protivovozdushnaya Oborona) was unable to counter this new threat and fight back massive air strikes from across the North Pole. It became necessary to build a chain of air defence radars along the frontiers and field new interceptor aircraft which could patrol the borders for an extended time, these tasks receiving the highest priority.

Initially, the patrol fighter role was filled by the Yakovlev Yak-25M (Yak-120) 'Flashlight'. By the mid-1950s, however, this subsonic interceptor – with a service ceiling of some 15000 m (49,212 ft) and armed with only a pair of 37-mm cannons – could no longer cope with fast, high-flying targets. One way to solve the problem was to develop a supersonic interceptor armed with air-to-air missiles – though not yet of the 'fire-and-forget' kind.





Aerial intercept weapons systems

When the first Soviet AAMs became available in the early 1950s, the defence industry began the development of aerial intercept weapons systems, comprising high-speed interceptor aircraft, beam-riding missiles and a fire control radar. All of the Soviet fighter makers – and even some design bureaux specialising in other types of aircraft – were working on such weapons systems. For example, OKB-155 led by Artyom Ivanovich Mikoyan and Mikhail Iosifovich Gurevich consecutively brought out the I-75, Ye-150 and Ye-152 heavy interceptors. OKB-51 under Pavel Osipovich Sukhoi developed the T-3-51 weapons system comprising the T-3 interceptor prototype (and its derivatives, the PT-7 and PT-8, which were the immediate precursors of the production Su-9 [T-43] 'Fishpot-A' interceptor) and K-5 or K-7L AAMs for same. Aleksandr Sergeyevich Yakovlev's OKB-115 tried adapting the K-8

Above left: One of the La-250/La-250A series poses with a pair of dummy AAMs in a retouched picture. Note the narrow-track undercarriage.

Left: '02 Red' (the 250A-II) is seen in flight in another retouched photograph. The calibration markings on the dummy missiles and the deflection of the slab stabilators are of interest.

AAM first to the Yak-25 and then to the more capable Yak-27; these missile-toting versions were designated Yak-25K-8 and Yak-27K-8, respectively. Even Andrey Nikolayevich Tupolev's OKB-156, which traditionally dealt with bombers and airliners, came up with the Tu-28-80 project envisaging the Tu-28 (Tu-128) 'Fiddler' heavy long-range interceptor and K-80 AAMs.

The first to propose a weapons system of this kind, however, were probably Semyon Alekseyevich Lavochkin and Viktor V. Tikhomeerov in 1953. The former headed OKB-301, another fighter design bureau of Great Patriotic War fame; the other was Director of NII-17, a Ministry of Aircraft Industry establishment tasked with avionics development. Lavochkin was willing to design both the fighter itself and its principal armament (air-to-air missiles), while Tikhomeerov would be responsible for the aircraft's fire control radar. Their proposal won support and, on 20 November 1953, the Soviet Council of Ministers formalised its approval by issuing a directive which ordered the development of the K-15 aerial intercept weapons system. The latter included four components: a long-range interceptor provisionally designated *izdeliye* 250, a K-15U radar (the 'U' probably denoted *upravleniye* [*snaryadami*] – missile control or guidance) for same, *izdeliye* 275 AAMs and ground-controlled intercept (GCI) equipment. The missiles had a maximum launch range of 15 km (8.1 nm), hence the digits in the system's designation.

The K-15 programme was a major effort in which 11 MAP divisions participated, along with six design bureaux from other ministries. The entire programme (i.e. aircraft and missile development) was supervised by S. A. Lavochkin, while the missile's control system was the responsibility of MAP's NII-2.

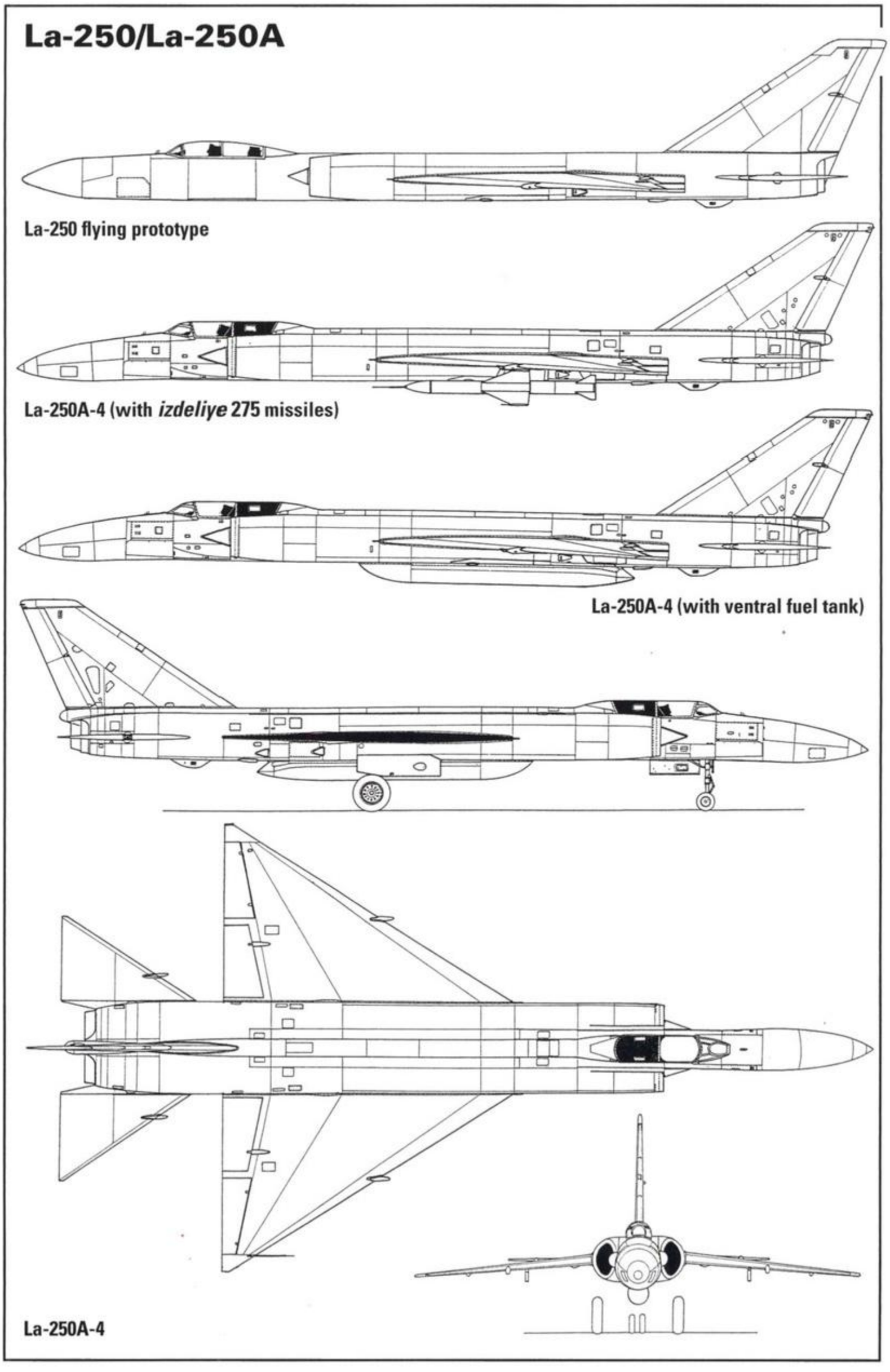
Herculean tasks

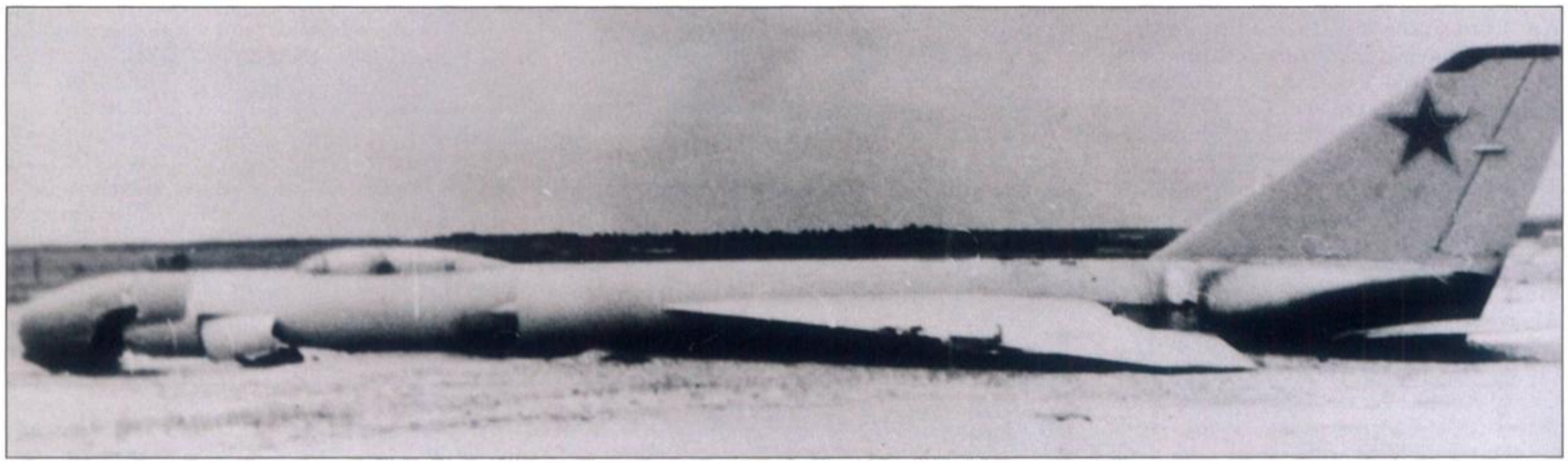
The task which OKB-301 had volunteered to fulfil was Herculean. It involved creating not only an aircraft of a totally new class but also air-to-air missiles, something with which the Lavochkin OKB had no prior experience. Every design aspect of the interceptor was new, from general arrangement to specific airframe structural details, from powerplant to control system to radar. True, the 250 was not the first Lavochkin aircraft with radar (this having been used on the *izdeliye* 200 two-seat heavy interceptor of 1949 and *izdeliye* 200B of 1952) – and, sure enough, the radar was designed elsewhere, but radar integration still had to be performed by Lavochkin engineers. To make matters worse, the development schedule was extremely tough and little time was available.

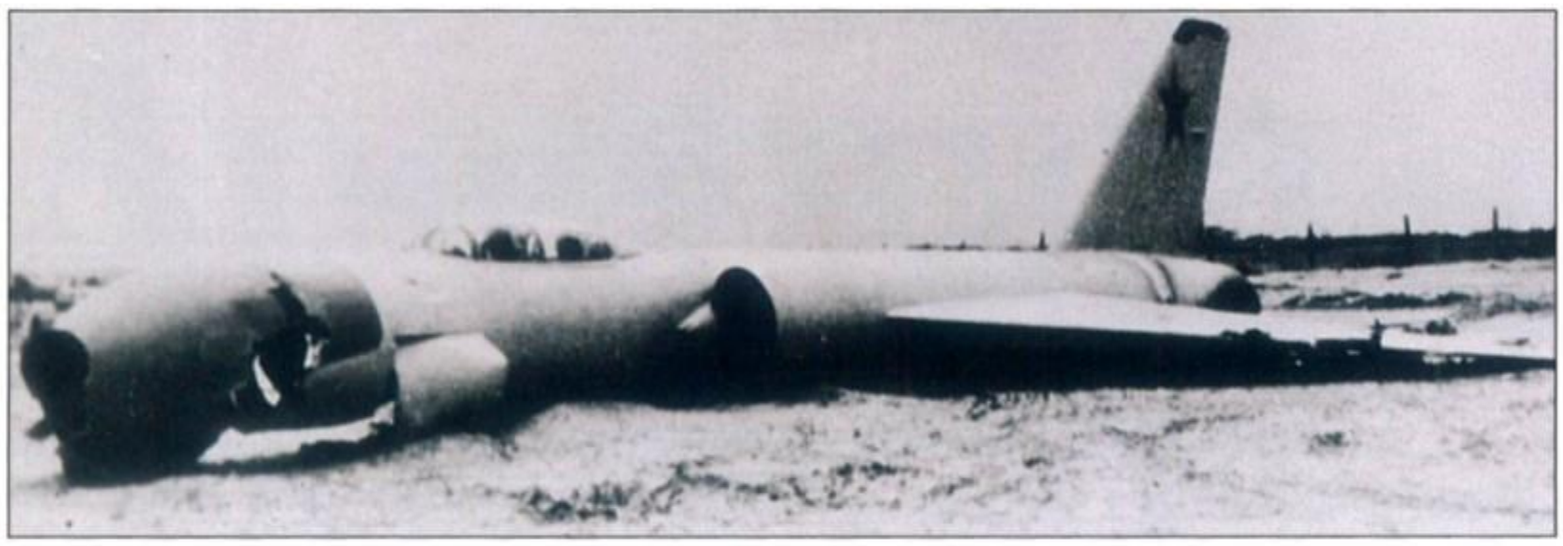
Pursuant to the above-mentioned directive, the aircraft was designed around two VK-9 afterburning turbojets rated at 117.65 kN (26,455 lb st), the latest product of OKB-300 under Vladimir Yakovlevich Klimov. It was intended to destroy targets flying at up to 20000 m (65,616 ft) and 1250 km/h (677 kt) within a 500-km (270-nm) combat radius; the specified endurance was 2.7 hours.

The air force's specific operational requirement (SOR) stated that the aircraft was to be capable of intercepting a solitary bomber in fully automatic or semi-automatic mode. The *izdeliye* 250 interceptor would be guided to the target's approximate location by a Vozdookh-1 (Air-1) GCI station and a Lazur (Prussian Blue) command link system. After that, the aircraft would acquire the target with its fire control radar at 30-40 km (16-21 nm), getting a target lock-on at 18-20 km (9.7-10.8 nm). Drop tanks would be carried under the wings to increase range, while the two *izdeliye* 275 AAMs would be semi-recessed in the fuselage, in tandem. The missiles had semi-automatic radar homing (SARH), i.e., the target needed to be illuminated all the way from launch to impact.

Interestingly, at the same time the Lavochkin OKB began swiftly developing missile systems. In parallel with the *izdeliye* 250 interceptor project, the bureau was working on the ill-starred Burya (Storm) intercontinental cruise missile. This was, likewise, new ground for Lavochkin so, predictably, development of both projects took quite a long time. (Rumour has it that the Burya cruise missile was killed off at the insistence of Sergey Pavlovich Korolyov who was eager to clear the way for his own R-7 intercontinental ballistic missile, itself later developed into the famous Soyuz launcher rocket. The Soviet defence budget just was not







Above and left: The first flight of the only* izdeliye *250 ended in the aircraft being written-off after a control harmonisation failure. A wheels-up landing was executed, but the aircraft was badly damaged by a fire and finally crashed into a sand bank after running out of tarmac.

big enough for both missiles.)

The general arrangement of the *izdeliye* 250 interceptor – or La-250, as it is sometimes referred to – was almost completed by July 1954. The aircraft featured completely new aerodynamics and a number of 'custom-made' equipment items, such as ejection seats, control surface actuators, landing gear wheels, etc. A full-scale wooden mock-up was built in order to find the best locations for the various equipment items and determine the size and shape of their access panels.

The La-250 had a long and slender fuselage, thin mid-set delta wings, a single swept fin and triangular all-movable stabilisers (stabilators). This layout had been selected after making calculations and numerous wind tunnel tests, both at the Central Aerodynamics & Hydrodynamics Institute named after Nikolay V. Zhukovskiy (TsAGI – Tsentrahl'nyy aeroghidrodinameecheskiy institut) and at the Moscow Aviation Institute (MAI – Moskovskiy aviatseeonnyy institut). The nose housed the powerful K-15U fire control radar, and both crew members – the pilot and radar intercept officer (RIO) – sat in tandem under a common aft-hinged canopy. The centre fuselage contained fuel tanks and avionics and was flanked by the supersonic air intakes; these had a quasi-elliptical cross-section and a small, fixed shock cone. The aft fuselage accommodated the engines, side by side. All three landing gear units retracted into the fuselage: the nose unit aft, the main units forward. Two *izdeliye* 275 AAMs were carried in tandem on the centreline, semi-recessed in the fuselage.

Work on the K-15 weapons system proceeded briskly at first, but it soon became apparent that development of the aircraft's major systems and components was running behind schedule. This applied primarily to the radar and the VK-9 engines. Throughout 1954 the Lavochkin OKB and NII-17 examined possible ways of placing the radar and the missiles on the La-250. Targeting by triangulation was eventually selected, in which the aircraft would manoeuvre toward the target as the latter was tracked, enabling the missiles to make very gentle turns on the way to the target (and thus allowing them to be stressed to a lower *g* limit).

The design of the missiles themselves changed several times. In its ultimate shape, the *izdeliye* 275 AAM utilised the classic layout with aft-mounted rudders and was powered by a single-chamber liquid-fuel rocket motor developed by A. M. Isayev. The missile was quite large, measuring more than 6 m (19 ft 8 in) in length; body diameter was 0.45 m (1 ft 5.71 in) and launch weight exceeded 870 kg (1,918 lb). Soon, however, development of this missile was discontinued for reasons explained below.

First setbacks

In early 1955, when the first prototype La-250 was already under construction at MMZ No. 301 in Moscow (the Lavochkin OKB's experimental plant), the programme suffered its first setback when the VK-9 turbojet was terminated. No existing engine could fit the projected size and weight of the aircraft. In order to meet the stated performance figures, Lavochkin opted for the AL-7F afterburning turbojet developed by Arkhip Mikhailovich Lyul'ka. However, the AL-7F was much less powerful than the stillborn VK-9, being rated at 73.54 kN (16,535 lb st) dry and 98.04 kN (22,046 lb st) with reheat, so the aircraft effectively had to be designed from scratch around the new engines.

Known in-house as *izdeliye* 250A, the new aircraft was smaller and lighter. The principal

Below and below right: The fourth prototype, two-seater '03 Red' (the 250A-III), was unpainted apart from the leading edge of its engine intakes (painted black to reduce glare) and the tip of its tailfin. Note that at this stage the aircraft lacked any national markings on its fuselage and tail.

armament now consisted of modified *izdeliye* 275A missiles on underwing pylons. Additionally, *izdeliye* 277 and *izdeliye* 279 AAMs were envisaged, the latter model with a nuclear warhead. The interceptor would have an upgraded K-15M fire control radar. To compensate for the reduced internal fuel capacity the 250A could carry a single 1350-litre (297-Imp gal) drop tank on the fuselage centreline; also, the avionics and equipment were suitably relocated to fit into the smaller airframe. This massive redesign made meeting the development schedule a nebulous proposition, but all the design bureaux involved in the K-15 project remained enthusiastic.

On 13 August 1954 Air Marshal S. Rudenko, Minister of Aircraft Industry P. V. Dement'yev and his deputy M. V. Khrunichev reported to the Council of Ministers as follows: "General Designer Comrade Lavochkin is developing a two-seat interceptor powered by two AL-7F engines, with a top speed of 1600 km/h [868 kt] and a service ceiling of 16000 m [52,493 ft]. The aircraft is equipped with a special [sic] radar designed to detect the enemy at 40 km [21.6 nm] range, enabling automatic accurate launch of missiles at 15-20 km [8.1-10.8 nm]. With appropriate modifications the aircraft can be armed with K-5 [air-to-air] missiles and unguided rockets. Once the K-5 short-range missiles with a range of about 5-6 km [2.7-3.2 nm] have been verified, Comrade Lavochkin's interceptor will meet the requirements for short-range interception as well."

The advanced development project of the 250A interceptor (featuring slightly uprated AL-7F-1 engines) was completed in October 1955 and approved early the next year. Compared to the original project, the aircraft's performance was slightly reduced; it was capable of destroying targets flying at up to 19500 m (63,976 ft) and 1,200 km/h (650 kt). It was possible to engage targets in both head-on and pursuit mode at 9-12 km (4.86-6.48 nm) range while flying at 5000-15000 m (16,404-49,212 ft).

Prototype completed

The above-mentioned La-250 prototype (the original *izdeliye* 250 interceptor laid down before work on the manufacturing drawings of the smaller *izdeliye* 250A had begun) was completed on 16 June 1956. Lavochkin decided to use this aircraft for stability and handling tests and as a systems testbed for the future 250A. Since the intended AL-7F-1 engines were not yet available, the first prototype was fitted with standard AL-7Fs rated at 67.65 kN (15,211 lb st). This was the only La-250 built in Moscow, for subsequent prototypes and the static test airframe would be built at aircraft factory No. 1 in Kuybyshev which was then producing the Mikoyan-Gurevich MiG-17 'Fresco-A'.

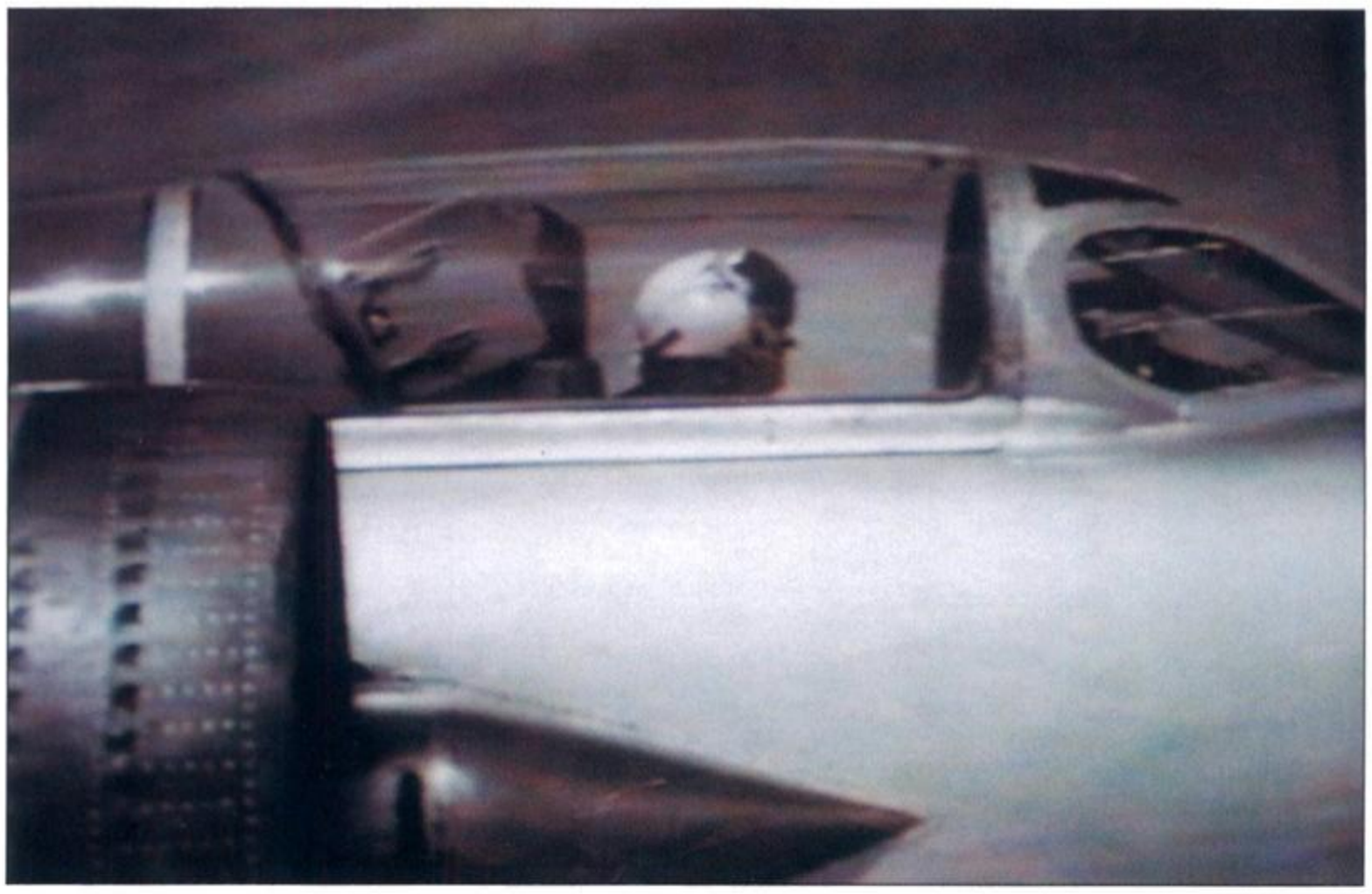
Engineer M. L. Baranovskiy was put in charge of the manufacturer's flight test stage. The project test pilot was A. G. Kochetkov, who had been transferred to OKB-301 from the Soviet Air Force Research Institute (NII VVS – Nauchno-issledovatel'skiy institut voyenno-vozdushnykh seel) in June 1953 at the request of Semyon A. Lavochkin.

The La-250 was trucked to the Flight Research Institute (LII – Lyotno-issledovatel'skiy institut) in Ramenskoye south of Moscow. The arrival of the strange-looking aircraft at the LII airfield caused a wave of excitement among the local personnel, and its long, lean profile and sheer size meant the interceptor was promptly nicknamed 'Anaconda'. This was the second 'snake' which Kochetkov had to 'charm' in his flying career, the first having been the Bell P-63C KingCobra which he had mastered in the USA in 1944, during Lend-Lease deliveries of these fighters to the USSR.

The ground tests and high-speed runs (some of them with short hops) went well, so on 16 July, exactly a month after the prototype's completion, A. G. Kochetkov and navigator N. P. Zakharov attempted a 'real' first flight. The La-250 immediately proved temperamental, to say the least – the attempt nearly ended in disaster. As the accident report testifies, two seconds after getting airborne the aircraft banked 4-5° to starboard, then started pitching and rolling, mostly with starboard bank. Kochetkov opted for an immediate landing. The La-250 touched down hard on its starboard main gear, bounced, then straightened out and landed on the edge of the runway some 800 m (2,624 ft) farther, catching fire. Trailing smoke and flames, it ran along the runway shoulder in a nose-high attitude, its brake parachute deployed. The parachute proved of little use: after 1100 m (3,609 ft) the aircraft crashed through the perimeter fence, running into a sand trap, and the landing gear collapsed. Zakharov was the first to leave the cockpit and, seeing that the aircraft was on fire, he warned Kochetkov, who immediately actuated the fire extinguishers.

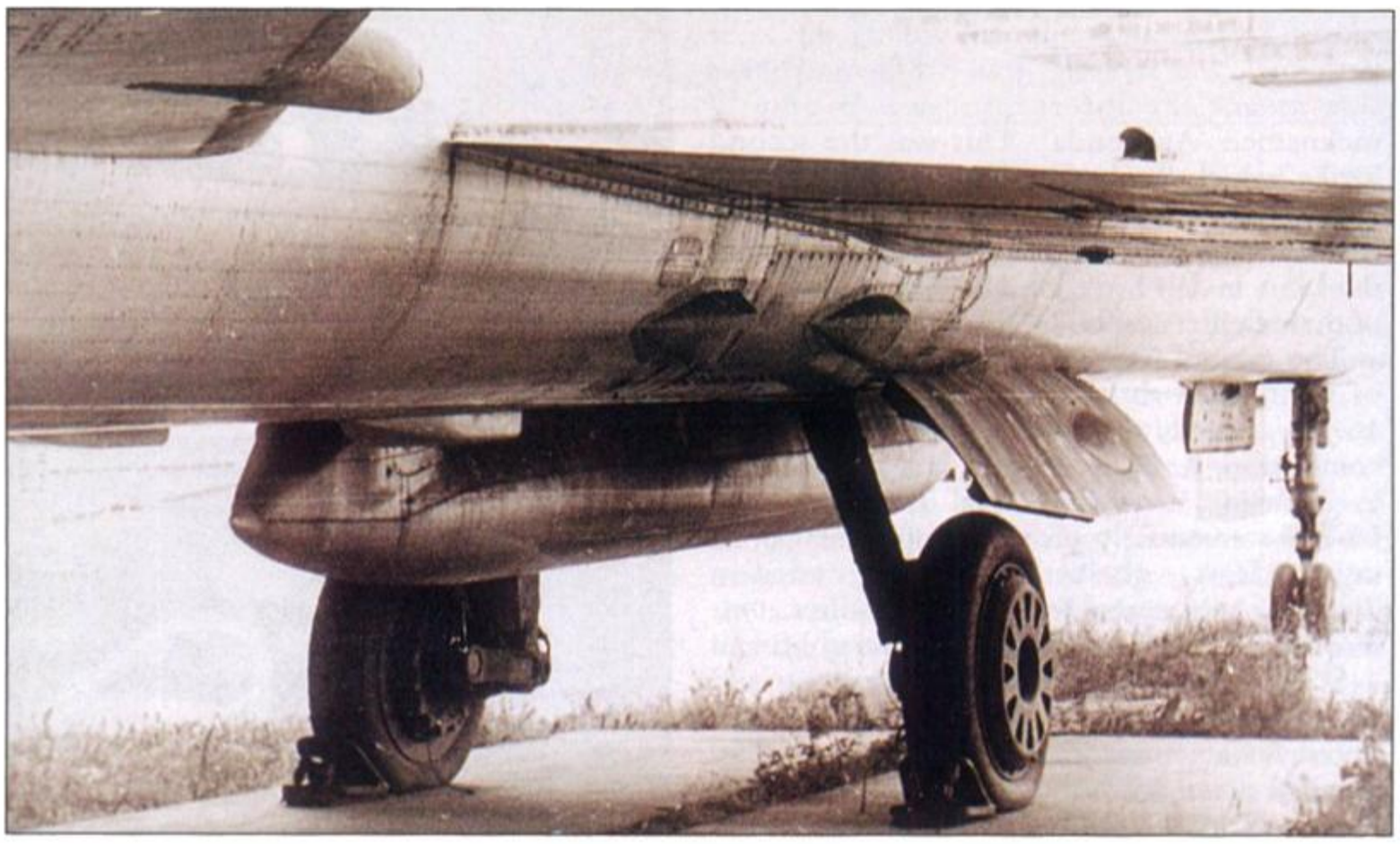
Incredibly, the pilot suffered nothing worse than bruises, while the navigator was unscathed. Undoubtedly, it was Kochetkov's high flying skills and considerable experience that stopped the first flight from ending fatally for both aircraft and crew. By then Kochetkov had mastered 96 indigenous and foreign aircraft types, amassing a total of 2,375 flying hours. During qualification checks he invariably earned the highest grades.

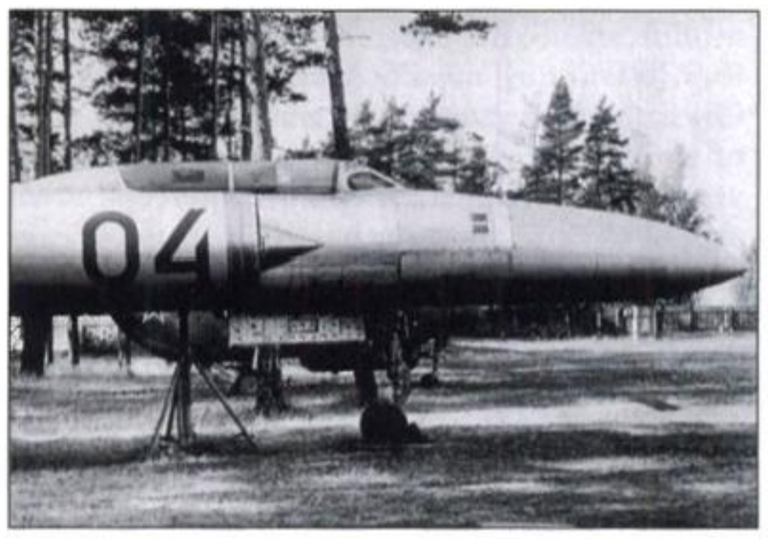
Investigation of the accident showed that the engineers designing the control system had 'overdone it', incorporating, to quote the accident report, "much bigger and more powerful hydraulic actuators than on the MiG-19 and Yak-25 aircraft. This caused a perceptible delay in aileron deflection [with respect to stick inputs – author] and hence roll oscillations." In other words, stick and aileron movement was out of sync and in trying to correct any unwanted bank, the pilot only made it worse. This was compounded by the fact that the actuators were irreversible and there was no feedback in the control system; the artificial feel unit was not informative enough.



Above and middle: Two views showing the aft-opening cockpit canopy, with the KL-2 ejector seat in place and the heavily framed five-piece forward canopy section on 250A-III '03 Red'.

Top: Seen here possibly seated in the 250A-IV prototype, A. G. Kochetkov was the test pilot for the La-250 programme.



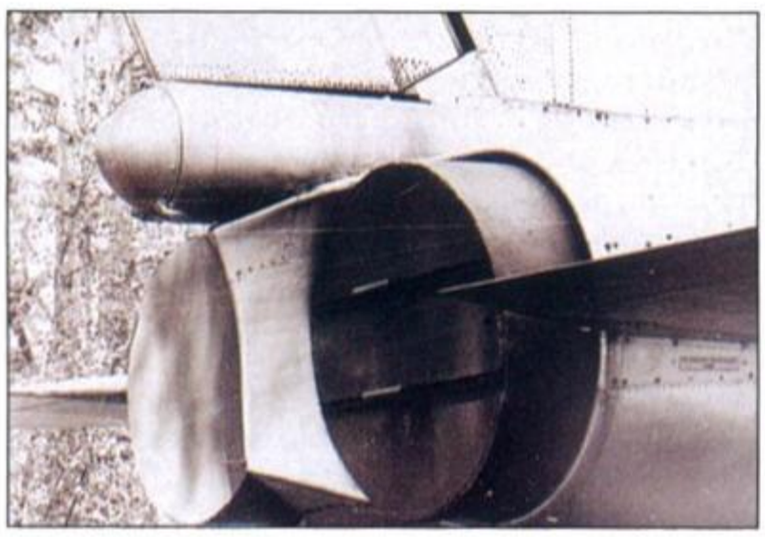


Above: The failure of the K-15M fire control radar resulted in '03' and '04 Red' being fitted with the Sokol-2 (RP-6 family) radar. For this change to take place some modification of the radome was required, the new nose having a distinct 'droop'.

Top: One of the main differences between the original* izdeliye *250 and the later 250As was the lengthening of the engine intakes in the latter, in which the intake mouth was directly beneath the cockpit.* Izdeliye *250A-IV is seen at Monino.

Above: A ventral fuel tank was necessary to provide the type with a useful range (above). Note also the stabilator anti-flutter weight in this view.

Below: The 250 programme was hampered by the cancellation of the desired Klimov VK-9 turbojet and the availability of the afterburing Lyul'ka AL-7F-1s (as fitted to '04 Red'). Sandwiched above the exhausts and below the rudder is the brake parachute fairing.

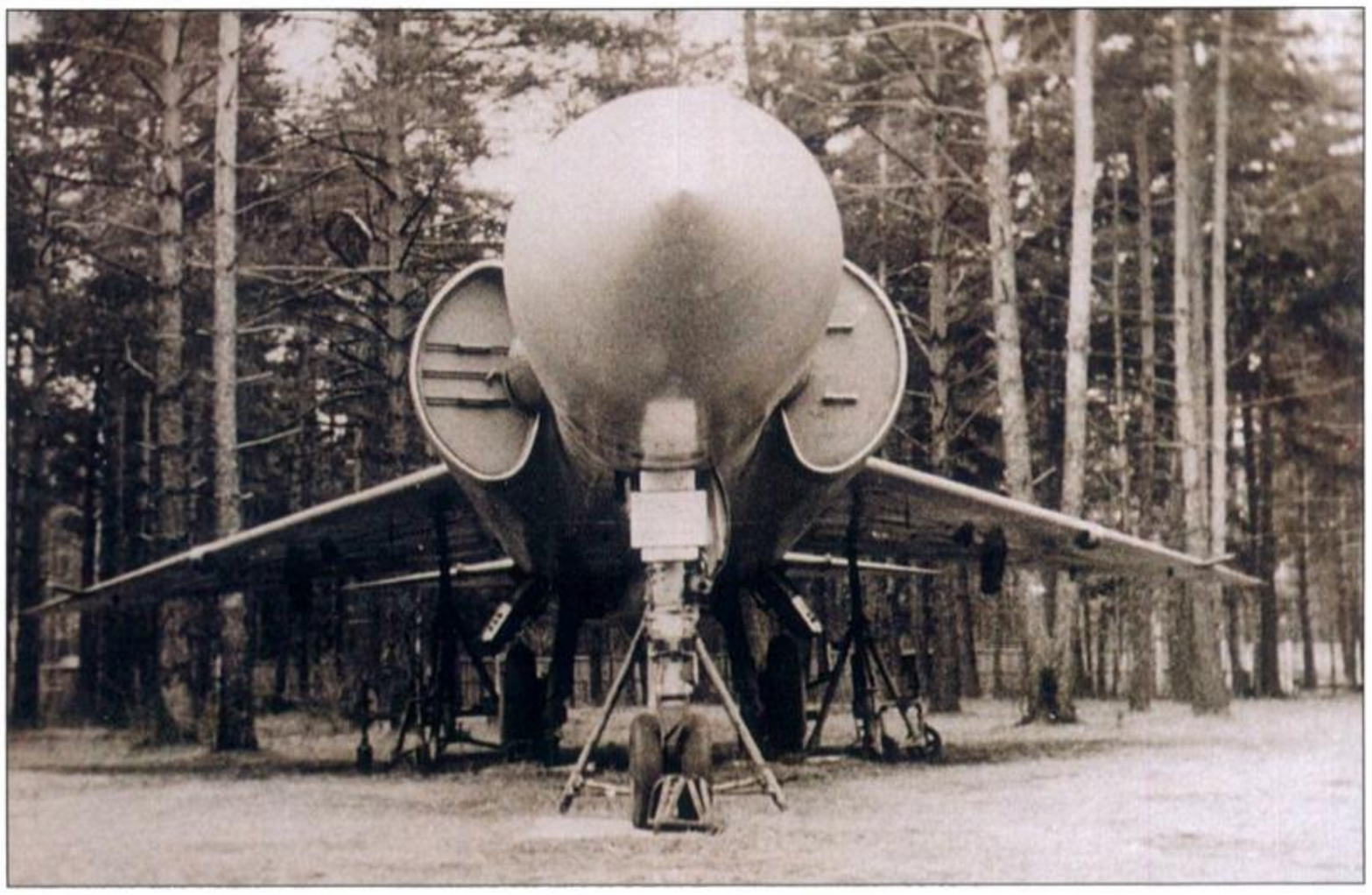


A special test rig simulating the operation of the La-250's control system was built at OKB-301. This 'iron bird', to use a term coined by Boeing, was 'flown' by test pilots Gheorgiy M. Shiyanov and Mark L. Gallay, whose reports confirmed the findings of the accident investigation board. The control system of the 'Anaconda' needed improvement.

Second prototype – *izdeliye* 250A

In the spring of 1957 the Kuybyshev aircraft factory completed the second prototype, which was also the first example of the *izdeliye* 250A. Designated 250A-I, this aircraft featured the modified control system and was again powered by AL-7Fs, as the AL-7F-1 was still unavailable. The second 'Anaconda' completed a series of ground engine runs and was slated to make its first flight in Kuybyshev, but the aircraft was ordered to be transferred to LII for tests. Carefully wrapped in tarpaulins (with due precautions to disguise its shape), the dismantled 250A-I was transported to MMZ No. 301 on a flatcar. The journey by rail revealed another serious design flaw: several bolts in the wheel wells which were made of a new grade of steel failed from the vibration. It was just as well that they did at this stage (and that the defect was discovered) for, had the bolts failed in flight, the result would undoubtedly have been another accident. The manufacturing technology was promptly changed.

From the Lavochkin plant the still-dismantled 'Anaconda' had to be trucked to LII. The 250A-I was quite a large aircraft and the tall fin could not be removed, so trolleybus and tram wires had to be lifted by special vehicles at several locations. Since the route lay through downtown Moscow – there was no alternative – the jet was carefully camouflaged once again, and a special security task force guarded the long convoy taking the aircraft to Ramenskoye from spectators. A large brigade of workers and engineers participated in the transport operation.



Above and right: Flanked by a Lavochkin La-15 'Fantail' to its left and a Yakovlev Yak-17 'Feather' to its right, the La-250A-IV is seen at Monino prior to restoration.

was repaired and returned to active status, making two more flights in 1959.

In order to hasten development it was decided to test some of the system's components separately from the aircraft. As noted earlier, the transformation of the 250 into the smaller 250A had led to a change in radar and missile type. The advanced development project of the modified *izdeliye* 275A AAM was completed in January 1956. The missile's estimated launch weight was now 800 kg (1,763 lb) rather than 500-600 kg (1,102-1,322 lb) as originally planned, while range decreased to 15 km (8.1 nm).

In 1958 the Kuybyshev aircraft factory produced an experimental batch of 50 *izdeliye* 275A missiles. A complete series of ground tests was performed, followed by several test launches in ballistic mode (a launch in guided mode was not possible because the missile's guidance system and autopilot were not yet available). Ten of the development missiles were converted to *izdeliye* 278 AAMs which differed in having a solid-fuel rocket motor; starting in April 1958, five were fired from a ground launcher.

By the time the K-15 weapons system was officially scrapped, the Kuybyshev factory had manufactured 49 more missiles, all incomplete. Additionally, several prototypes of the *izdeliye* 277 radar-homing AAM were built and bench-tested.

Change in radar equipment

The K-15M fire control radar was experiencing delays and it was decided to equip the 'Anaconda' with the proven Sokol-2 (Falcon-2) radar. However, this had a shorter detection range, which necessitated the development of the smaller and shorter-range *izdeliye* 280 AAM with active radar homing. The aforementioned *izdeliye* 279 AAM with a nuclear warhead never got beyond the project stage.

Meanwhile, the K-15M radar was finally fitted to the fourth prototype designated 250A-III and commenced ground trials on this aircraft. This was followed by the fifth prototype, 250A-IV, which had a complete weapons fit and mission avionics suite, including a Sokol-2 radar (since the intended K-15U and K-15M still could not be perfected). This aircraft also had a faired ciné camera under the aft fuselage for filming drop tank separation tests. Coded '03 Red' and '04 Red', respectively, the 250A-III and 250A-IV flew without major trouble, though minor incidents did happen.

One weak spot of the 'Anaconda' was its mainwheels, or more precisely, its tyres. The 250A was a heavy aircraft by the day's standards, so the mainwheels were exceptionally large. The tyres were slick, being custom-made for the 'Anaconda' and therefore hand-crafted, not baked in a mould like production tyres. Their service life was short; cracks and cuts were often discovered after a flight, which meant the tyres had to be changed. On one occasion a mainwheel overheated and caught fire on landing but, luckily, the skilful actions of test pilot Arkadiy Bogorodskiy prevented this from turning into yet another major accident.

Delays in the delivery of the uprated AL-7F-1 led to changes in the test programme schedule. The *izdeliye* 275A missile was tested using a ground launcher, and nine launches were made before the end of 1958. Since no information has ever been published on this weapon, its specifications might be of interest to the reader. The missile was powered by an Isayev liquid-fuel rocket motor rated at 27.75 kN (6,239 lb st), with a burn time of 23 seconds. Launch weight was 600 kg (1,322 lb), including a 140-kg (308-lb) warhead, and top speed was 3600 km/h (1,952 kt). The missile's maximum range was to be 27 km (14.6 nm). The *izdeliye* 275A was 5.7 m (18 ft 8.41 in) long, with a body diameter of 0.45 m (1 ft 5.71 in.) and a wingspan of 1.55 m (5 ft 1.02 in). All figures are manufacturer's estimates.

By May 1958 all components of the K-15 weapons system – i.e. the aircraft, the missiles and the radar – were finally ready for testing, yet the numerous accidents and development problems caused the trials programme to drop far behind schedule. The interceptor showed disappointing performance: top speed was only 1080 km/h (585 kt) instead of the planned 1610 km/h (873kt), service ceiling was 13300 m (43,635 ft) instead of 16100 m (52,821 ft) and the time required to reach 12000 m (39,370 ft) was 5 minutes 24 seconds – more than twice the intended 2 minutes 30 seconds. This and the many missile projects with which OKB-301 was busy led Semyon A. Lavochkin to give up the idea of refining and testing the K-15 in mid-1959.

Before that, however, in 1958 the Council of Ministers tasked the State Committee for Aircraft (GKAT – Gosudahrstvennyy komitet po aviatseeonnoy tekhnike) with completing the manufacturer's tests of the *izdeliye* 250A interceptor with AL-7F engines. After that, the

prototypes were to be transferred to NII VVS for State acceptance trials in the second quarter of 1960. GKAT was ordered to determine the advisability of further development work on the 'Anaconda' together with the customer, as the documents put it (i.e. with the Air Defence Force).

Soviet Air Force C-in-C Marshal Konstantin A. Vershinin, however, was not disposed to wait so long. In 1958 he addressed the Soviet government, stating that "development of the K-15 aerial intercept system is taking extremely long (since 1953), for which OKB-301 must be held responsible. The La-250 [sic] aircraft is becoming obsolete. The slow progress of the system is illustrated by the fact that the aircraft made one flight in 1956, six flights in 1957 and 14 flights in 1958."

In July 1959 the government issued a directive cancelling the K-15 weapons system. This, however, did not imply that weapons in this class were viewed as unnecessary – the government had simply run out of patience. Indeed, Soviet military intelligence was bringing alarming reports of new, even faster and higher-flying strike aircraft being developed in the West, making the danger of a hostile incursion into Soviet airspace even more acute. The biggest threat was presented by the Boeing B-52 Stratofortress and the Snark cruise missile.

The general operational requirement for a long-range missile-toting interceptor was revised. Soon after, the PVO received the Su-9-51 weapons system, a successful derivative of the T-3-51 comprising the Su-9 'Fishpot-A' interceptor and four K-5 (RS-2-US) SARH missiles (NATO codename AA-3 'Anab'). Also, development of the Tu-28-80 long-range aerial intercept system (which was effectively a competitor of the K-15) was well advanced by then.

By way of comparison, the Mikoyan/Gurevich Ye-150 and Ye-152 'Flipper' experimental heavy interceptors which were part of the Uragan (Hurricane) weapons system working with the Vozdukh-1 GCI system – and which, like the La-250A, did not progress beyond the prototype stage – were much faster, reaching speeds in excess of Mach 2. Even with the intended AL-7F-1 engines, the top speed of the 'Anaconda' would have been much lower.

Lavochkin's swansong

The 250A interceptor was Lavochkin's swan song – the last of his aircraft to be built and to fly. Of the multitude of jet fighters developed by OKB-301 in the post-war years, only the La-15 (La-174D) 'Fantail' was to enter production and service, and then in small numbers (about 500 were built). By some quirk of fate, Lavochkin aircraft were plagued by misfortunes, whereas the bureau's missiles had a measure of success. Small wonder that the Soviet government under Nikita S. Khruschchev (notorious for his predilection towards ballistic missiles, which proved damaging to many aircraft design bureaux) decided that OKB-301 should become a specialised missile manufacturer and discontinue aircraft development altogether.

Even though the La-250A did not complete its test programme, the effort was not in vain. Development of the K-15 weapons system was the first practical application of the complex approach to weapons system design in the USSR, the first case when research, development and manufacturing enterprises in various fields worked in close co-operation. The expertise accumulated with the 'Anaconda' was transferred to Tupolev's OKB-156, which put it to good use when designing the Tu-128 heavy interceptor; this aircraft entered flight test in 1961, remaining in PVO service for many years. The La-250 programme also provided TsAGI with considerable experience in wind tunnel tests. Finally, the Lavochkin OKB became the first in the USSR to create an analogue flight simulator concurrently with a new fighter.

The only surviving 'Anaconda', the 250A-IV ('04 Red'), is now on display at the Russian Air Force Museum in Monino south of Moscow.

Yefim Gordon, original translation by Dmitriy Komissarov

Above and below: Of the five La-250s, the* izdeliye *250 and 250A-I crashed, two were scrapped (La-250A-II at Zhukovsky and La-250A-III at an unknown location) and the La-250A-IV was saved for the Soviet air force museum at Monino, where it has recently been restored. Sadly it remains, with many other exhibits, displayed outdoors, where it is at the mercy of the harsh Russian winter.

Specification

Lavochkin *izdeliye* 250A

Wing span	45 ft 7⅝ in (13.9 m)
Wing area	86.02 sq ft (80 m²)
Length overall	87 ft 11⅝ in (26.8 m)
Height	21 ft 3⅜ in (6.5 m)
Normal TOW	54,012 lb (24500 kg)
MTOW	60,626 lb (27500 kg)
Empty weight (estimated)	41,816 lb (18968 kg)
Fuel load*	internal, 19,180 lb (8700 kg) with drop tank, 21,384 lb (9700 kg)
Maximum payload	27,557 lb (12500 kg)
Maximum speed†	clean, 1056-1118 mph (1700-1800 km/h) with missiles, 994 mph (1600 km/h)
Landing speed	122 kt (225 km/h)
On-station loiter time	at 39,370 ft (12000 m) and 542 kt (1000 km/h), 2 hrs 18 mins
Climb to 12000 m (39,370 ft)†	2 mins 50 secs
Service ceiling	55,774 ft (17000 m)

* on the first flight the fuel load was no more than 11,463 lb (5200 kg)

† target figures

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